DOCUMENT RESUME

ED 422 903 IR 019 101

AUTHOR	Boyd, Sally
TITLE	Learning by Bytes: Computers in the Classroom. Evaluation of the Learning Enhancement with Information Technology Project.
INSTITUTION	New Zealand Council for Educational Research, Wellington.
SPONS AGENCY	Ministry of Education, Wellington (New Zealand).
ISBN	ISBN-1-877140-13-9
PUB DATE	1997-00-00
NOTE	161p.
AVAILABLE FROM	New Zealand Council for Educational Research, P.O. Box 3237, Wellington, New Zealand.
PUB TYPE	Numerical/Quantitative Data (110) -- Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Case Studies; *Computer Assisted Instruction; Computer Attitudes; *Computer Uses in Education; Educational Change; *Educational Technology; Foreign Countries; Information Technology; Instructional Effectiveness; Secondary Education; Student Attitudes; Tables (Data); Teacher Attitudes; Teaching Methods; Use Studies
IDENTIFIERS	*New Zealand

ABSTRACT

This evaluation of the Learning Enhancement with Information Technology project examined the impact of the introduction of an information technology initiative on students' and teachers' attitudes toward computing and students' learning. The evaluation was designed as a case study involving Palmerston North Girls' High School (PNGHS) and a matched comparison school (School X), and took place during the 1995 and 1996 teaching years. The project involved the use of computers in the classroom by all students at PNGHS studying 6th and 7th form accounting and economics, or 7th form mathematics with statistics. The combination of qualitative and quantitative information collected over the course of this evaluation showed a variety of changes over time for both students and teachers. Overall, although teachers and students raised a number of issues concerning the details of the way the project was implemented, a number of positive outcomes were evident. The use of computers in the project, and the classroom environment that this use facilitated has enhanced students' skills and learning in a variety of ways. Chapters include: (1) "Introduction and Background"; (2) "Teacher Perspectives"; (3) "Student Perspectives"; (4) "Perspectives on Learning"; and (5) "Summary." Sixty-six tables and figures illustrate findings; the forms and questionnaires used in the evaluation are appended.(AEF)

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LEARNING BY BYTES: COMPUTERS IN THE CLASSROOM

EVALUATION OF THE LEARNING ENHANCEMENT WITH INFORMATION TECHNOLOGY PROJECT

Sally Boyd

A report for the Ministry of Education
by the
New Zealand Council for Educational Research
Te Rūnanga o Aotearoa mō te Rangahau i te Mātauranga
Wellington
1997

New Zealand Council for Educational Research
PO Box 3237
Wellington
New Zealand

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ISBN 1–877140–13–9

Distributed by NZCER Distribution Services
PO Box 3237
Wellington
New Zealand
Ph (04) 384 7939
Fax (04) 384 7933
E-mail: <sales@nzcer.org.nz>

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Acknowledgments

This evaluation has benefited from the input and co-operation of a large number of people. Thanks for their participation are especially due to the teachers and staff at Palmerston North Girls' High School who gave freely of their time and energy throughout all phases of the evaluation, and without whose assistance this research would not have been possible: Sue Cassells, Lil Garland, Russell Gordon, Chris Hodge, Alison Kelliher, Andrew McKnight, Diane Pech, Peter Rawlins, Esmee Rowden, Jenny Scott, and Helen Sussmilch. Thanks are also due to the project co-ordinator and the teachers at School X who participated in and assisted with the evaluation, and the 2 Hamilton teachers who worked on the writing with wordprocessors exercise—Per Rorholt and Denise Weren.

My sincerest thanks also go to Cedric Croft who acted as a mentor, adviser, and editor through all phases of this project, and who, through his contributions to many discussions, has helped shape this evaluation. I wish especially to acknowledge the contribution Cedric's assessment expertise has made to this research.

Members of the Advisory Committee provided invaluable assistance throughout the course of the evaluation: Russell Boniface, Simon Ford, and Lynne Whitney from the Ministry of Education; Lil Garland and Esmee Rowden from Palmerston North Girls' High School; Pat Nolan from Massey University; Andrew Kear from the New Zealand Post Primary Teachers' Association; and Peter Keegan, Graham Wagner, and Richard Benton from NZCER.

Many NZCER staff were involved in this project and I wish to express my appreciation to Karyn Dunn, Anne Gilbert, and Lia Mapa for research assistance during the course of the evaluation, Barb Bishop for data processing, staff in the library for the processing of interloans, Carlene Grigg and Nicky McKibbin who produced the graphs and made final wordprocessing changes to the final report, and Fay Swann for editing.

EXECUTIVE SUMMARY

Introduction

This summary provides an overview of the evaluation of the Learning Enhancement with Information Technology project at Palmerston North Girls' High School (PNGHS). Funded by the Ministry of Education, this evaluation examined the impact of the introduction of an information technology initiative on students' and teachers' attitudes towards computing, and students' learning. The evaluation was designed as a case study involving PNGHS and a matched comparison school (School X). The evaluation took place during the 1995 and 1996 teaching years.

The project involved the use of computers in the classroom by all students at PNGHS studying 6th and 7th form accounting and economics, or 7th form mathematics with statistics. The ratio of students to computers was 3:1. Students studying these subjects at School X were surveyed to provide a comparison.

In 1995 teachers at both schools completed a questionnaire at the beginning and end of the year; teachers at PNGHS were interviewed 3 times, and completed diary records for a period of 1 week in each term. In both 1995 and 1996 students at both schools completed a questionnaire at the beginning and end of each year. In 1996 a series of 5 substudies, focusing on the following areas, was designed to look at the effects of the use of computers on students' learning:

- Students' development of practical and conceptual information technology skills.
- The interaction between the use of computers and students' ability to work co-operatively.
- The effect of a computer tutorial on students' understanding of a mathematical concept.
- The effect of the use of wordprocessing software on students' report-writing skills.
- The effect of the use of computers on students' academic achievement as measured by external examination marks.

Teachers and Teaching Practice

Over all the main theme to emerge from the teacher questionnaires, diaries, and interviews was one of change for PNGHS teachers, that is changes in:

- dynamics between and among students and teachers;
- perceptions towards the use of computers,
- how computers were integrated into the classroom, and the types of learning that can be facilitated due to their use; and
- teachers' workload and professional skills as a result of participating in the project.

At the time of the first interviews teachers were concerned about the delay in setting up the project, the perceived lack of support and resources available in the wider community, and the impact of the project on their workloads. By the second and third terms many of the issues raised in the first term had been resolved. The major issues for teachers over the course of 1995 were:

- *Workload:* The increased workload due to the project and the need for more time for planning, developing resources, and reflection.
- *Training:* Most teachers thought they needed more initial computer training but had difficulty finding courses that related specifically to their needs and subject areas. Most felt that training had been overlooked somewhat in favour of purchasing hardware and software.
- *Software:* The lack of available subject-specific teaching software for Macintosh computers was a concern for teachers.
- *Student access:* Teachers thought a 2:1 ratio of students to computers was more beneficial than a 3:1 ratio.
- *Subject-specific concerns:* Computers appeared to be easier to integrate into some subject areas, for example, accounting used mostly generic wordprocessing and spreadsheet software. This was not the case for mathematics with statistics.
- *Student training:* Most teachers considered that the implementation of the project would have been smoother if students had been taught basic keyboarding skills before they started.
- *Leadership:* Staff changes during the course of the project altered the balance of teacher skills between departments. Having a staff member to act as a resource person aided the smooth functioning of the project.
- *School resourcing and support:* Investing in computer equipment was not a one-off purchase; additional and unplanned costs arose during the course of 1995, for example, extra paper and new overhead projectors.

The major changes that occurred over the course of 1995 for teachers were:

- A high initial workload, decreasing over time.
- Increasing confidence with hardware and software.
- Increased use of the project software for a range of planning purposes.
- Development of further professional skills and collegial support networks.
- The identification of personal training needs and the meeting of some of these needs.
- Changes in classroom dynamics with a move to more informal student-centred classrooms, which necessitated some changes in management styles and roles for teachers and students.
- A positive change in attitudes towards the use of computers for learning, including a refocusing of viewpoints on what and how students were learning from participating in the project.
- Related to the above, teachers began to develop ways to validate their views on students' learning and integration of theory.

A number of themes emerged from teachers' comments on the integration of computers into the classroom:

- The ways that computers were used varied between subjects, that is, as a tool in accounting, and as a tutor in mathematics with statistics.
- Over time teachers developed a pattern of more selective use of computers in the classroom; and made some changes to the way computer use was integrated into their lessons.
- Over the course of the year students became more independent in their use of computers.
- Teachers' and students' perceptions changed over the course of 1995 from viewing computers as the focus of a lesson to viewing them as a tool that was part of general classroom practice.

A number of impacts on students' learning due to the use of computers and changing classroom dynamics was observed by teachers, including:

- The development of students' skills in a range of areas, such as computer literacy, presentation skills, group work, peer tutoring, self-teaching skills, and problem-solving skills.
- Increased understanding of some concepts due to the greater range of learning styles available, for example, visual demonstrations.
- Increased student motivation in classes where computers were used.
- Increased range of roles possible for students due to changes in classroom dynamics.

Students

From the information collected from the student questionnaires it appeared that most of the significant changes for students occurred at PNGHS, for example:

- During 1995 PNGHS students' attitudes towards computers became significantly more positive;
- During both years PNGHS students' knowledge of computer terms increased significantly;
- During both years PNGHS students' use of computers outside school increased;
- As the project progressed, PNGHS students were more likely to indicate that they knew a moderate amount about computing and agreed with positive statements about the use of computers in the classroom.

At PNGHS there appeared to be some differences in the cohort of students starting the project in 1996 compared with those who started in 1995. Essentially, the 1996 cohort appear to have started where the 1995 cohort left off in terms of computer usage and confidence. Even given the differences between the cohorts, approximately four-fifths of students in both years indicated that they had acquired a range of skills through participating in the project: mainly increased knowledge of computing over all and spreadsheet and presentation skills. Just over 50 percent indicated that they had transferred the skills they had learnt to other subject areas. Many PNGHS students indicated that they had improved other skills, such as the ability to work in a group and problem solve, as a result of using computers.

Students at PNGHS were divided as to whether the use of computers directly affected their learning of the project subjects, with approximately 50 percent preferring computer assignments and stating that the use of computers made their subjects and lessons more interesting. Students at both schools held similar views on whether it was advantageous or disadvantageous to use computers in the classroom. Approximately 50 percent of students thought it was or would be advantageous, one-third were neutral, and one-sixth thought it was or would be disadvantageous.

Compared with students at PNGHS, students at School X were more likely to state that they would like to use a computer at school more often. PNGHS students stated that the major advantages of using computers were the time saved, and the general computing, wordprocessing, and spreadsheeting skills they were acquiring. Disadvantages varied between subjects: for accounting and economics students a major issue was the initial time taken to learn how to use computers; for students studying mathematics with statistics, having the computer doing calculations for them was the major disadvantage.

Learning Enhancement

The data collected from the 5 learning enhancement studies indicated that the use of computers in the project, and the classroom environment that this use facilitated, has enhanced students' skills and learning in a variety of ways:

- Over the course of 1996, students displayed increased practical and conceptual information technology skills. All students surveyed were able to complete basic tasks such as displaying data in a spreadsheet, using a spell check, and printing documents. The majority of students had acquired more complex skills, for example, importing graphics.
- The use of computers to complete co-operative tasks aided accounting students' development of essential skills especially with regard to information skills and the presentation of material.
- Although mathematics-with-statistics students could complete and understand a computer-based tutorial on confidence intervals, this tutorial did not appear to enhance their understanding of confidence intervals. Students needed more integration between the tutorial and theory to get maximum benefit from the tutorial.
- The use of wordprocessors improved the quality of internally assessed economics projects of 7th form students. This improvement occurred for students at both schools.
- Participation in the project appeared to have no significant positive or negative effects on students' performance in end-of-year Bursary examinations. It appears though that the wordprocessing of internally assessed projects has the potential to enhance students' grades until such time as wordprocessed assignments are the norm.

Summary and Implications for Further Research

The combination of qualitative and quantitative information collected over the course of this evaluation showed a variety of changes over time for both students and teachers. Over all, although teachers and students raised a number of issues concerning the details of the way the project was implemented, a number of positive outcomes were evident.

From the information presented in this report it is possible to conclude that students' learning and skills were enhanced over the 2-year evaluation period. Though this evaluation covered only the implementation phase of the project, given the trends reported here it is likely that further gains would be evident in the long term. It is also likely that more changes or gains from projects of this nature would be evident if the existing teaching system was adapted more to suit new technologies, especially with regard to the current examination system, pedagogy, and curriculum resources. From the experiences gained from this research, the following are suggested as resource and policy developments that could support future information technology initiatives in schools:

- Curriculum resources which contain suggestions for computer-based exercises.
- Advice to teachers on suitable software for their courses and computer platforms, including how to incorporate the use of this software into lesson plans.
- Research into the implications of the use of new technologies for the current examination system and curricula, and for all assessments within the New Zealand Qualifications Framework.

CHAPTER 1

INTRODUCTION AND BACKGROUND

Introductory Literature Review

This introduction summarises New Zealand research on the impact of computer use on students' learning and classroom processes. Some overseas case studies relevant to the research described in this report are included. In addition to this introduction, literature related to some of the findings of this research is discussed in the main text of this report.

Background to Information Technology Use in New Zealand Schools

In 1990 the report of the Consultative Committee on Information Technology in the School Curriculum (known as the Sallis Report) set out a goal for information technology (IT) use in New Zealand schools:

> That all students through access to appropriate information technologies at all levels of education, will leave school with the necessary skills to take their place in an information society. (p. 3)

Views vary on the optimum number of computers necessary to achieve this goal. The Sallis report suggested 2 computers to a classroom. Anderson (1995) notes that this optimum level has doubled in the last few years (in *Education for the 21st Century* a computer-to-student ratio of 1:5 is mentioned) although at present in New Zealand schools there is no national standard provision for IT. Policy statements from the Ministry of Education on the use of IT in schools are broad, leaving interpretation and implementation to individual schools, for example, one of the national education aims as listed in the document *Education for the 21st Century* is:

> Attainment of qualifications to enable all to participate successfully in the changing technological and economic environment. (Ministry of Education, 1994, p. 30)

As can be seen from the above quotation, IT use is part of the New Zealand curriculum. Nightingale and Chamberlain (1991), when summarising the data collected in the New Zealand section of an International Association for the Evaluation of Educational Achievement (IEA) study, commented that, as there has been no single policy on IT use in schools in New Zealand, the growth of IT in schools has been haphazard, and consequently there is wide variation in the types of hardware, software, and computer expertise in schools.

The use of computers in New Zealand schools continues to grow; Owens (1996) reported that all secondary schools, and nearly all primary schools had student or staff computers. The growth in school computers is an international trend as reported in IEA studies (Pelgrum, Janssen Reinen,

& Plomp, 1993), though Pelgrum and Plomp (1996) note that the use of computers tends to be at the school rather than the classroom level.

New Zealand Studies of Learning and Classroom Processes

Learning Enhancement and Attitudes Towards Computers

A number of New Zealand authors have provided guidelines for the use of computers to aid learning (Lai & McMillan, 1992; Lai, 1996; Ryba & Anderson, 1990). Few New Zealand studies have specifically examined questions of whether or how students' learning is enhanced through the use of computers. One of the possible reasons for this lack of studies is that the changes which are observed are often difficult to quantify. As Lai (1992) states, it is difficult to assess the impact of the use of computers as there are a range of variables, such as the role of the teacher, that change when computers are introduced to a classroom.

One long-term case study of the use of computers in a New Zealand secondary school is the Freyberg Integrated Studies Project. This project involved the development of an integrated curriculum, linked by the use of computers for form 4 to form 6 (McKinnon 1995). McKinnon reported that students in the integrated programme had more positive attitudes to study, and achieved at a higher level in School Certificate examinations compared with their peers in the traditional programme. Increases in student motivation when computers are used are also reported by Podmore and Craig (1989). Another change which is commonly mentioned in the literature is a move from a teacher-centred to a student-centred classroom management style which is facilitated by the use of computers (McKinnon, 1995; Lai, 1992; Ryba & Anderson, 1990).

Some of the studies in the Evaluation of Exploratory Studies in Educational Computing, commissioned by the Ministry of Education, comment on developments in students' skills and learning through the use of computers. Philips (1995) studied the use of wordprocessors to develop skills of written expression. Philips reported that although students' writing skills improved it was difficult to attribute any changes to the use of wordprocessors alone. Philips did report that students had positive attitudes towards the use of wordprocessors. Podmore and Craig (1989) found that the use of computers facilitated social interaction between children aged 4 to 7 years.

Chamberlain and Kennedy (1991) surveyed teachers in 2 New Zealand schools on their opinions on the effect of the use of computers on students' learning. Teachers were uncertain as to whether students' achievement levels could be increased through the use of computers, but most agreed the use of computers could facilitate co-operation between students.

Planning and Integration of IT Initiatives into the Classroom

Most New Zealand research on the use of computers in schools concentrates on the conditions that are necessary to take maximum advantage of new technology, and discusses teachers' concerns about the lack of training and technical advice available to them. In their report on a case study of the use of computers in 2 New Zealand schools Chamberlain and Kennedy (1991) presented a number of recommendations from the teachers involved in the study:

- that school-based training programmes be developed to introduce teachers to the types of software available in their subject area;
- that a central body be set up to provide advice and information on educational software to lessen the problems teachers were having finding educationally relevant software; and

- that national guidelines be developed to incorporate computing within existing subjects.

The need for technical support, ongoing teacher training, and educational support continues to be mentioned by many other New Zealand authors. Thomas (1995), in a report of the results of a survey on the use of computers in mathematics classes, reported that 71 percent of secondary school teachers saw lack of teacher confidence and training as an obstacle to using computers in the classroom. Other issues were hardware and software availability, lack of time, lack of money, and lack of access. Thomas concluded that training and support is vital for the development of computer use in classrooms. This conclusion is also reached by Gilmore (1993), Atmore (1995), and Hawk (*Education Review*, 1996).

Other issues mentioned by New Zealand authors include the increased workload for teachers at the initial stages of computer introduction (Podmore & Craig 1989). In an article about the "lighthouse" technology schools, the evaluator (Hawk, 1996), in addition to the issues mentioned above, summarised other main concerns of teachers including:

- The purchase and installation of hardware and software took longer to achieve.
- The need for long-term planning and budgeting for technology use and maintenance.
- Installation, technical assistance, and software costs being overlooked in favour of hardware.
- The difficulty experienced by teachers in integrating technology into lesson plans.

McKinnon (1995), when reporting on the Freyberg project, also identified the need for professional development. He noted that teachers' initial focus on teaching students IT skills changed over time to a focus on how to achieve curriculum objectives through the use of computers. He concluded that although teachers saw the positive contribution that the IT initiative brought to the school, continued funding to support the project was an issue.

Overseas Studies of Learning and Classroom Processes

Learning Enhancement and Attitudes Towards Computers

Overseas research on the effect of the use of computers on students' learning shows mixed results. Gardner, Morrison, Jarman, Reilly, and McNally (1992) summarised some of the findings and issues which arose from a Northern Ireland study of learning enhancement and classroom processes in which 235 students, at the primary or junior secondary level in 9 schools, were given laptops. The authors found that IT-related learning enhancement was easily shown (that is that students' IT skills increased due to the use of spreadsheet and wordprocessing software), but curriculum-related learning enhancement was less obvious and difficult to measure. The authors report that there was qualitative evidence of improved motivation, subject enjoyment, and a high quality of work presentation but this was not confirmed by quantitative assessment of attitudes. Achievement in the subjects assessed—mathematics, science, and English—did not differ significantly between the focus and the comparison schools.

The ImpacT Report (Watson, 1993) described the results of another major UK study of the effects of IT on children's achievements in primary and secondary schools. This project involved 2300 students in 87 classes matched in pairs, according to usage of technology, as either high or low. Students' achievements in mathematics, science, geography, and English were compared between the high and low technology groups.

The researchers concluded that IT did make a contribution to students' learning but this was not consistent across the range of ages and subject areas in the project. There appeared to be a minimum threshold of IT use necessary for enhancements to be detected, and the current provisions in most schools were below this threshold. The researchers also noted that some students had difficulty working in a collaborative environment. Increased student motivation, concentration, and interest due to the use of computers were reported as positive outcomes of the study. The authors also observed significant increases in students' achievement on a test of IT concepts and skills.

Other overseas authors mention that student-centred management styles are promoted by the use of computers (Watson, 1993; Shears, 1995; Gardner *et al.*, 1992) and that the use of computers increases student motivation (Stanford, 1986; Watson, 1993; Gardner *et al.*, 1992; Shears, 1995; Rowe, 1993). Increases in student motivation due to the use of computers is not universally reported by overseas authors: Pelgrum and Plomp (1996) note that international data on student enjoyment of computers in schools shows downward trends, indicating that schools did not appear to be increasing students' motivation to work with computers. They comment that the wearing off of the "novelty effect" of computers as they are used more in schools may have contributed to this trend.

Shears (1995) when describing an Australian project in which 10 schools were given 25 laptops each, concluded that not enough "hard" evidence was available to say whether the use of computers enhanced students' learning. Most of the evidence reported was anecdotal or indirect. Shears commented that there appeared to be little agreement about what exactly to assess, and therefore about accepted measures to use. Positive effects of the project, noted in some of the case studies, included:

- Increased maturity of students, and their willingness to work in groups.
- Development of work presentation skills.
- The use of spreadsheets to create graphs allowed students to spend more time interpreting their work.

Other issues for teachers were:

- The realisation that they need to instruct students on how to use spell checks and editing tools.
- The difficulties some students faced if they did not have keyboard skills.

Rowe (1993), in a summary of another Australian study—the Sunrise project—reported that achievement, as measured by a battery of tests on areas such as mathematics' comprehension, language usage, and written expression, did not vary significantly between the Sunrise and the non-Sunrise control group. Rowe saw this as an indication that when students were required to perform tasks manually they were not disadvantaged by the use of computers.

Rowe also noted that students who learnt successfully with computers also had positive attitudes towards computers. Students' anxiety levels towards computers decreased over the course of a year when computers were used in the classroom. Computer anxiety or computer phobia is one factor, commonly mentioned in the literature, that is seen as a barrier to students' willingness to adopt new technology (Miller & Varma, 1994; Pelgrum & Plomp, 1996). From their international study of the use of computers in schools, Pelgrum and Plomp (1996) reported that the majority of students thought computers were relevant to their daily life in and outside school.

Planning and Integration of IT Initiatives into the Classroom

Gardner *et al.* (1992), when reporting on the study mentioned previously, concluded that portable computers were functionally capable of providing for all aspects of the curricula in question. They noted that teachers commented on the flow-on effects of using computers, such as students transferring computer skills into other subject areas. Teachers involved in this study mentioned many concerns similar to those of New Zealand authors with regards to the planning and implementation of IT initiatives in schools, for example:

- Teachers required training in techniques for using IT in teaching.
- The need for teacher access to IT resources for lesson planning and preparation.
- All teachers reported having to spend a great deal of time familiarising themselves with IT before they felt confident to plan purposeful lessons.
- There was some evidence that the computer usage restrained the delivery of the curriculum as the first month of the teaching term was taken up with computer familiarisation and many teachers were behind in schedules.
- Teacher workload and stress increases due to the initial high level of technical problems.
- The need for technical assistance in classrooms for the introduction of computers.
- Initial anticipation of lesson timing and lesson planning was difficult for teachers.
- Lack of students' keyboard skills was a hindrance to full utilisation of the software.
- Less able students had problems with the concepts and procedures of some software.
- Teachers noted that they were not aware of the software available in their subject areas and knowledge in this area did not increase over the course of the project.

Gardner *et al.* noted that teachers' concerns about technical assistance and planning time allocations decreased over time.

Shears (1995) compared Australian principals' attitudes to a list of problems developed by the IEA studies in educational computing and found that a majority of principals agreed that:

- there are insufficient numbers of computers available in schools,
- there are insufficient numbers of peripherals (e.g., printers),
- there is difficulty in keeping equipment in working order,
- there are limitations to computers (e.g., out of date),
- there is not enough software for instructional purposes,
- there is not enough help for supervising computer-using students and teachers,
- there are difficulties in integrating computers into the classroom instruction practices of teachers,
- integration of computer use in the existing prescribed curriculum is difficult,
- teachers lack knowledge and skills about using computers for instructional purposes,
- insufficient expertise and guidelines for helping teachers to use computers instructionally are available,
- there is not enough technical assistance for operating and maintaining computers in schools,
- there are problems in scheduling enough computer time for classes,
- there are insufficient training opportunities for teachers,
- there is inadequate financial support, and

- there is not enough time to develop lessons in which computers are used.

Of the 10 case studies reported on by Shears most included comments on the need for adequate resourcing and professional development, and the need to increase the computer confidence of teachers. Rowe (1993) also commented on the lack of basic training and experience with computers evident in Australia, and the need for well-designed teacher-development programmes.

Mitchell and Loader (1993), in their description of the learning community at Methodist Ladies' College in Australia, noted the importance of the role of teachers in the successful implementation of classroom innovations. They noted that additional time for teachers to plan in collegial groups was needed but was not available in sufficient quantity due to funding issues. They also noted a need for the development of a new curriculum that includes the impact of new technologies on schools and society, and that these developments tend to fall on teachers who already have increasing workloads.

The authors of the ImpacT Report (Watson, 1993), also concluded that the effective implementation of IT initiatives was dependent on the role of teachers, which demanded substantial knowledge and understanding of a range of software, and consideration of classroom management and teaching styles, especially with regard to collaborative work. The teachers in this study expressed concerns about ongoing training. The authors noted that further help was needed in formulating policies and strategies for integrating computers into the school system.

Summary

In summary some enhancement of students' learning and skills through the use of computers is reported both in New Zealand and overseas, though measurement of these gains is difficult as there are a number of other factors apparent which are intertwined with computer use. Some major international concerns, consistently raised by research on computer use in the classroom, are teacher IT training, the provision of assistance in planning for the integration of computers into the everyday functioning of the classroom, and funding of IT initiatives.

Background to the Evaluation

In early 1994 the principal of Palmerston North Girls' High School (referred to as PNGHS) was approached by the Ministry of Education to design a computer-assisted learning project. After discussion and the presentation of a proposal by PNGHS, contract funds were allocated by the Ministry to cover some of the costs of the project. In addition, funding was provided for an evaluation of the project. A 2-year evaluation study was designed by the New Zealand Council for Educational Research in consultation with the Ministry of Education and PNGHS. This report describes the objectives and outcomes of this evaluation.

Description of the Project at PNGHS

The project involved using computers to enhance teaching and learning in 3 areas: 6th and 7th form accounting and economics and 7th form mathematics with statistics. In 1995 this comprised a total of 11 classes and in 1996, 10 classes. Two existing classrooms were set up as computer rooms: each room contained 9 Macintosh LCIII (MAC) computers, 8 for student use and 1 for teacher use. Each

room also contained a printer and a datashow. The layout of these rooms allowed students to work either on computers or at desks if required. Students in each subject area undertook all of their lessons in these computer rooms. The ratio of students to computers was 3:1, and the mean class size at the start of both 1995 and 1996 was 20 students. Computers in each room were networked using Ethernet, allowing students and teachers access to a shared file. A range of software was purchased: the ClarisWorks 2.1 suite of wordprocessing, spreadsheet, and database software that came with the hardware for use in all subject areas; PCInfos and MACGlobe databases for use primarily in economics; and FlowCharter, EquationSolver, Models 'n' Data, ANU Graph, Hypercard Mathematics with Statistics, and StatView Student for use in mathematics with statistics.

Some resources necessary for the project were already available at PNGHS; these included overhead projectors (OHP) for use with the datashows and 2 older style MACs in teacher resource rooms. In addition to the 2 project classrooms, PNGHS has a computer laboratory containing approximately 20 networked MACs. A full-time computer technician was available in the laboratory and some of the technician's time was contracted to the project to answer queries and solve technical problems. Two other computer-based courses were available: form 6 and form 7 computer studies. Students at PNGHS received a 10-week block class on computer skills in the 3rd form and a further set in the 6th form.

Figure 1 shows a timeline for the project as initially planned by staff at PNGHS. This timeline also includes some indications of the actual timing of events. Various modifications were made to the timeline as the project progressed, for example, the computer equipment was intended to be in place at the beginning of the last term of 1994, but due to supplier problems it did not arrive till the end of November. This caused a shortening in the time teachers had available for familiarisation with the hardware and software, resource development, and lesson planning.

Figure 1 *Planned and Actual Project Management Timeline*

PLANNED		ACTUAL
	PLANNING THE PROJECT	
Early - Jul 94	Deciding on the scope, hardware, software, and layout for the project.	Early - Jul 94
	⇓	
	SETTING UP THE PROJECT: MANAGEMENT	
Aug - Sep 94	Converting 2 classrooms to computer rooms, e.g., altering wiring, setting up hardware and security systems, purchasing new furniture.	Aug - Dec 94
	⇓	
	SETTING UP THE PROJECT: TEACHER PLANNING	
Aug 94 - ongoing	Investigating available commercial/school-based software.	Aug 94 - ongoing
	⇓	
Aug - Sep 94	Identifying suitable learning activities. Modifying schemes and assessments to include computer activities.	Aug 94 - Jun 95
	⇓	
	TRAINING AND DECISION MAKING	
Oct - Nov 94	Ordering and loading software. Staff training (5 half days) on software. Department meetings to develop lesson plans, learning resources, etc.	Nov 94 - Jun 95
	⇓	
Nov 94 - ongoing	Teachers released from junior classes after seniors left at the end of 1994 for planning, training, and development.	Nov 94 - ongoing
	⇓	
Dec 94 - Jan 95	Computers taken home to continue planning and familiarisation.	Dec 94 - Jan 95
	⇓	
Feb 95 - ongoing	Six-weekly teacher meetings to monitor progress and discuss issues. One free period a week allowed for resource development, lesson planning, and software exploration for some teachers in 1995.	Feb 95 - ongoing
	⇓	
	INTRODUCTION TO STUDENTS	
Feb 95	Ten introductory computer lessons for all project students. Information to students and parents about project.	Feb 95
	⇓	
	SOLVING UNFORESEEN ISSUES	
Mid 95	Two laptops provided for teacher planning. Better quality OHPs purchased for datashow projection. New software purchased for mathematics with statistics.	Mid 95
	⇓	
	REFLECTION	
End 95 - ongoing	Teacher evaluation of the project. Subject scheme alteration. Refining old, and developing new, lesson plans and resources.	End 95 - ongoing

Skills and End-of-Course Objectives Identified by PNGHS

PNGHS staff identified a number of research issues and end-of-course objectives for the project. These were used to shape the form of the evaluation.

PNGHS Research Issues

(1) The performance of students with access to computers during the year should be enhanced in [the] Bursary examination.
(2) Students with computers should display greater confidence, on average, in using computers as a tool than those students without. This should be evident in both selective and elective applications (i.e., when students are told what to use, and when they choose an appropriate application program).
(3) Students with computers should be more comfortable with various formats of [subject-based] information because they will have greater practice designing their own format as required to solve the task problems.
(4) Students who are computer adept should be able to translate skills learnt using one computer application program to other similar packages, e.g., ClarisWorks to Microsoft Works, Microsoft Excel to Lotus 1-2-3.
(5) The speed and design capabilities of the computer should enable students to spend more time practising the skills of analysis, interpretation, making decisions, devising alternative solutions, evaluating ideas, etc., and so should enable students to develop greater proficiency in these areas as well as greater understanding of them.
(6) Computer-aided learning should assist the development of appropriate report writing, particularly with respect to structure and logical presentation of ideas. Wordprocessing should assist the edit function of report writing.

Accounting End-of-Course Objectives

(a) Display improved keyboard proficiency.
(b) Use a wordprocessing package to produce written material.
(c) Use a spreadsheet package to produce accounting information.
(d) Design and use formats suitable for presentation of ideas and data effectively for various audiences.
(e) Produce pictorial/graphical representations of ideas and data.
(f) Complete task work quicker than students presenting solutions manually.

Economics End-of-Course Objectives

(a) Display improved keyboard proficiency.
(b) Use a wordprocessing package to produce written material.
(c) Access, design, and manipulate databases of economic information.
(d) Use a spreadsheet to enable creation of graphs and charts to illustrate economics information and ideas.
(e) Use simulations of real economics activities.
(f) Complete task work quicker than students presenting solutions manually.

Mathematics with Statistics End-of-Course Objectives

(a) Use a statistical package to present data and calculate statistics.
(b) Understand a demonstration of Central Limit Theorem.
(c) Prepare simple programs using algorithms.
(d) Use spreadsheet applications for a study of series and numerical methods.
(e) Use spreadsheets or databases to collect, store, and sort statistical data.
(f) Use wordprocessing functions to prepare written analysis of mathematical observations.

Evaluation Research Questions and Contract Objectives

The research questions address the research issues and objectives suggested by PNGHS and the general question of the impact on students and teachers of the introduction of an IT-mediated approach to classroom instruction. They focused on 2 areas; teacher attitudes and experiences of the implementation of an IT programme, and student participation and achievement under an IT-mediated approach in comparison with a more traditional approach to instruction. The research questions set out in the contract were:

(a) What impact does an IT-mediated approach have on student and teacher attitudes?
(b) Is end-of-course academic achievement in the areas under investigation enhanced by an IT-mediated approach?
(c) Are students at PNGHS learning via IT, achieving at a higher level in relation to the specific skills listed [*i.e., the PNGHS research issues and end-of-course objectives*]? Do achievement levels in these skills change over time?
(d) What interaction is there between home environment, particularly in relation to IT, and curricular incorporation of IT at school? What is the impact of school and home interactions?

Research Design

To address the research questions a comparative case-study design was employed for the collection of data. In order to provide a comparison with PNGHS a "matching" school was identified. Data were collected from both schools over the 1995 and 1996 teaching years.

Characteristics of the Comparison School

The comparison school was a single-sex girls' state secondary school with a similar socioeconomic intake and school philosophy to PNGHS. (In 1995 both schools' decile rating was 9. In 1995, 66 percent of PNGHS and 75 percent of the comparison school's leavers attained a 7th form qualification (Ministry of Education, 1996).) In this report the comparison school will be referred to as School X.

At the start of 1995 School X had 2 computer laboratories containing 20 networked MACs and 20 networked IBM-compatible computers. In addition to this, 4 departments (English, mathematics, economics, and accounting) had a computer for staff and student use. Three largely computer-based courses were offered: form 3 keyboarding, form 6 computer studies, and form 7 business studies. The school had a part-time computer technician.

Research Details

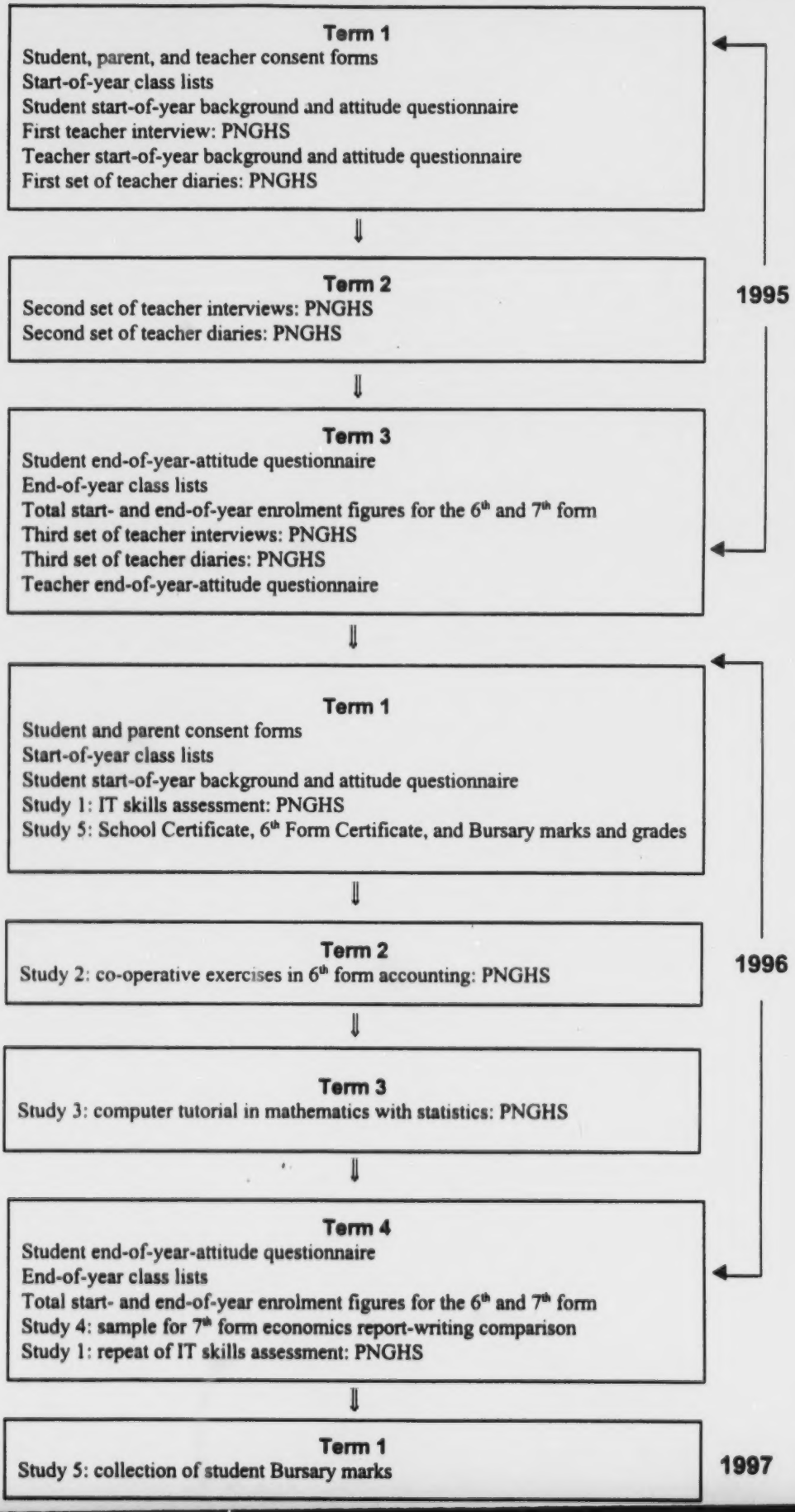
The evaluation was conducted in 2 phases. The first phase, the introduction of the project in 1995 to PNGHS, was documented from the teachers' perspective by a series of interviews, questionnaires, and snapshot diaries. Information was collected from students at both schools at the start and end of the year in the format of a questionnaire. In the second phase of the project in 1996, a series of 5 substudies was designed to assess specific aspects of computer-assisted instruction as described in the PNGHS research issues, the PNGHS end-of-course objectives, and the evaluation research questions. The student questionnaires were repeated with students new to the project in 1996.

Consent forms, as per the requirements of the Privacy Act (1993), were designed for students, teachers, and the parents of students participating in the evaluation. These forms were distributed with the help of teachers at the start of the 1995 and 1996 school terms.

Timeline for the Evaluation

Figure 2 shows a general timeline for the collection of data for the evaluation. Unless otherwise stated the information was collected from both schools.

Figure 2 *Evaluation Data Collection Timeline*


Term 1
Student, parent, and teacher consent forms
Start-of-year class lists
Student start-of-year background and attitude questionnaire
First teacher interview: PNGHS
Teacher start-of-year background and attitude questionnaire
First set of teacher diaries: PNGHS
Term 2
Second set of teacher interviews: PNGHS
Second set of teacher diaries: PNGHS
Term 3
Student end-of-year-attitude questionnaire
End-of-year class lists
Total start- and end-of-year enrolment figures for the 6th and 7th form
Third set of teacher interviews: PNGHS
Third set of teacher diaries: PNGHS
Teacher end-of-year-attitude questionnaire
1995
Term 1
Student and parent consent forms
Start-of-year class lists
Student start-of-year background and attitude questionnaire
Study 1: IT skills assessment: PNGHS
Study 5: School Certificate, 6th Form Certificate, and Bursary marks and grades
Term 2
Study 2: co-operative exercises in 6th form accounting: PNGHS
Term 3
Study 3: computer tutorial in mathematics with statistics: PNGHS
Term 4
Student end-of-year-attitude questionnaire
End-of-year class lists
Total start- and end-of-year enrolment figures for the 6th and 7th form
Study 4: sample for 7th form economics report-writing comparison
Study 1: repeat of IT skills assessment: PNGHS
1996
Term 1
Study 5: collection of student Bursary marks
1997

Research Instruments and Data Collection Strategies

Questionnaires

Information on the attitudes of teachers and students towards the use of computers was collected using a "pre and post" design. Questionnaires were completed by students and teachers at the beginning and end of 1995. The student questionnaires were repeated at the start and end of 1996.

The start-of-year student questionnaire was the same for both schools. Students were asked questions on their current attitudes towards the use of computers and the subjects they were studying, previous experiences with computers, use of computers outside school, parents' attitudes towards computers, demographic profile, and knowledge of computer terminology.

The end-of-year questionnaires repeated selected questions from the start of the year in order to assess whether there had been any change in students' attitudes towards computing, knowledge of computer terms, or home computer usage over time. Additional questions were asked of PNGHS students about their use of computers in the project, for example, whether they had acquired new skills as a result of participating in the project, what were the advantages and disadvantages of using computers in each subject area, and their opinions on the use of computers and learning.

Students' attitudes towards the use of computers were assessed using the *Computer Anxiety Index (Version AZ)* (CAIN), developed by Maurer and Simonson (1984), and part of the *Standardized Test of Computer Literacy* (STCL) by Simonson, Montag, Maurer, Oviatt, and Whitaker (1992). (Permission to use the scale has been obtained from the authors. A copy of the PNGHS start-and-end-of-1996 student questionnaires are included in appendix A (the CAIN is omitted due to copyright restrictions).)

Questionnaires were given to teachers at the start and end of 1995. These questionnaires focused on teachers' previous computer experience, their use of computers for teaching prior to 1995, and their attitudes to computers in the classroom. Teachers' attitudes towards the use of computers were assessed using the "use of computers in the classroom" scale developed by IEA and reported in Nightingale and Chamberlain (1991).

In addition the PNGHS questionnaire asked some preliminary questions about software and hardware training and support. The attitude measures were repeated in a short end-of-year questionnaire given to teachers at both schools. A copy of the start-of-1995 PNGHS teacher questionnaire is contained in appendix B.

Interviews

Teachers at PNGHS were interviewed once a term over the course of 1995. The aim of the interviews was to document the process of introducing computers to the classroom from the perspective of the teachers involved and illuminate any issues that arose during this process. The interviews were structured and focused on issues such as the selection and usefulness of software; teachers' experiences of using the software and hardware; contacts developed by teachers; professional development and training; and the impact of the use of computers on students, classroom management, lesson planning, and workloads. A copy of the October interview schedule is contained in appendix C.

Diaries

Teachers at PNGHS completed a set of snapshot diaries over the course of 1 week in each term in 1995. A diary record was completed by all teachers in the project for every lesson in a project subject for that week. The aim of the diaries was to focus on individual lessons to see how computers were incorporated into the classroom instruction programme in order to develop a day-by-day picture of the use of the computers and a feeling for whether this usage changed over time. Each diary looked at a lesson in terms of planning, content and objectives, computer usage, and classroom management techniques. In total 150 diaries were received from the 8 teachers involved, that is 50 in May, 53 in July, and 47 in October. A copy of the October teacher diary is contained in appendix D.

School Records

Start- and end-of-year class lists for the subjects in question and overall numbers of students starting and finishing the 6th and 7th form were collected to provide data for the calculation of retention rates.

1996 Substudies

Over the course of 1995 the evaluation programme for the second phase in 1996 was altered from the original conceptualisation of a pre- and post-test of academic achievement to focus on a wider range of skills. A programme was developed specifically to provide information on contract objective (c):

> Are students at PNGHS learning via IT, achieving at a higher level in relation to the specific skills listed by PNGHS? Do achievement levels in these skills change over time?

These studies also aimed to evaluate attainment of some of the end-of-course objectives for each subject area. After discussion on the research issues, 2 areas for further research were added: co-operative learning and essential skills as defined in *The New Zealand Curriculum Framework* (Ministry of Education, 1993).

Five ways of looking at the overall question of whether the use of computers enhances learning were developed for the second phase of the evaluation. The assessments were spread over the range of subjects in the project in order to have the least impact possible on any one subject area. Therefore, students studying each subject were involved in a "case study" of a particular facet of the effects of learning with computers. The following information describes each of the measurements, the research issues addressed or end-of-course objectives assessed, the research instruments designed, and the sampling framework for each study.

Study 1: Information Technology Skills Assessment

This study assesses the PNGHS research issue (2), that students should display greater confidence in using computers as a tool, and the end-of-course objectives, for all subject areas, that students should display improved keyboard proficiency, and be able to use spreadsheets appropriately to display information.

A 3-part assessment was developed and trialled on a class of PNGHS 6th form students at the end of 1995. Minor modifications were made to the assessment before it was presented to all PNGHS students who had started the project in 1996 at the start and end of the school year. The assessment consisted of:

Part A: A practical spreadsheet exercise to be completed using a spreadsheet software,
Part B: A short multiple-choice test on general IT skills (some questions were adapted, with permission from the authors, from the Functional Information Technology Test (Pelgrum *et al.*, 1993).
Part C: A self-assessment form on which students were asked to indicate their mastery of a range of IT skills.

Students were given 1 or 2 introductory lessons on spreadsheets before completing the assessment to ensure that they could access the necessary software. In total 110 of a possible 112 (98 percent) students completed the assessment in the first term of 1996. At the end of the fourth term a lesser number of students completed the assessment due to an administration error, that is, 71 of a possible 98 (72 percent). A copy of Part A and Part C is contained in appendix E (Part B is omitted due to copyright restrictions).

Study 2: Analysis of Co-operative Exercises in 6th Form Accounting

The purpose of this study was to assess the possible impact of the use of computers on the students' group and social skills. This study related to the PNGHS research issue (5) that the speed of computers should enable students to spend more time devising alternative solutions, etc., and to the accounting end-of-course objective (c) that students were able to use a spreadsheet to produce accounting information. This study also looked at the area that had been added to the PNGHS research issues at a later date, the interaction between the use of computers, collaborative learning, and the development of essential skills.

The exercise had a quasi-experimental design and involved both 6th form accounting classes at PNGHS, a total of 32 students. In the second term of 1996 students in the 2 classes completed 2 co-operative tasks developed by the accounting teachers at PNGHS. Each group completed one task with the aid of a computer and the second task by hand.

After each task students completed a self-rating form. In addition, each group was observed and rated, by 1 or 2 observers using the same categories as the self-rating form. The rating forms and 1 of the tasks were trialled on a class of accounting students at the end of 1995. Minor modifications were made before the forms were used in 1996. A copy of the student and observer rating schedules and the 2 tasks are contained in appendix F.

Study 3: Analysis of a Computer Tutorial in Mathematics with Statistics

The purpose of this exercise was to assess whether a computer tutorial on the subject of Confidence Intervals (CI) increased students' level of understanding of CI, and if there was an increase, at what point this occurred. This exercise was developed from the PNGHS end-of-course objectives for mathematics with statistics, (b) that students would be able to understand a computer demonstration of concepts such as the Central Limit Theorem.

This exercise was completed by 49 students in the three 7th form mathematics-with-statistics classes at PNGHS at the start of the third term. A copy of the demonstration and lesson rating forms are contained in appendix G.

Study 4: Comparison of 7th Form Economics Students' Report-Writing Skills

The aim of this study was to assess the possible impact of the use of wordprocessing software on the quality of students' internally assessed projects. This study related to the PNGHS research issues (3) that students using computers should be comfortable with various formats of economics information, (5) that the capability of computers should enable students to spend more time practising the skills of analysis, interpretation, decision making, and evaluating ideas, and (6) that computer-aided learning should assist the development of appropriate report writing, etc.

In 1996 students at PNGHS and School X completed the same internally assessed 7th form economics project. From these students a sample of 10 matched pairs was selected from both schools. Two independent markers with experience in assessing 7th form economics were contracted to amend a series of 5-point scales, developed from the PNGHS research issues. The markers then used the amended scales to grade the reports. A copy of the assignment and the scale used to evaluate the projects is contained in appendix H.

Study 5: Analysis of Internal and External Marks and Grades

To assess the possible impact of the use of computers on students' Bursary results, the School Certificate, 6th Form Certificate, and Bursary results of students in the project for their 7th form year in either 1995 or 1996 were collected from both schools.

This study was designed to assess the contract objective (b) Is end-of-course academic achievement in the areas under investigation enhanced by an IT-mediated approach? The study also relates to the PNGHS research issue (1), that the performance of students with access to computers during the year should be enhanced in the Bursary examination. Students' accounting, economics, mathematics, mathematics with statistics, and English scores and grades were transferred to a database for analysis of variation. English was added as a control variable.

Sampling

Students

Questionnaires were sent to the total cohort of students studying subjects in the project. In 1995, at PNGHS, of the 159 students in the project, all agreed to participate in the evaluation. Of these, 154 (97 percent) returned questionnaires at the start of the year. At the end of the year, out of a possible 147 students, 140 (95 percent) returned questionnaires.

In 1996, at PNGHS, of the 112 students new to the project, 105 agreed to participate in the evaluation. Of these, 99 (94 percent) returned questionnaires at the start of the year. At the end of the year, out of a possible 90 students, 87 (97 percent) returned questionnaires.

In 1995, at School X, of the 157 students studying subjects in the project, 138 agreed to participate in the evaluation. Of these, 125 (91 percent) returned questionnaires at the start of the year. At the end of the year, out of a total of 125 students, 117 (94 percent) returned questionnaires.

In 1996, at School X, of the 152 students newly starting subjects in the project, 140 agreed to participate in the evaluation. Of these, 128 (91 percent) returned questionnaires at the start of the year. At the end of the year, out of a possible 122 students, 119 (98 percent) returned questionnaires.

The sample size for the substudies has been discussed in the previous section.

Teachers

At PNGHS all teachers involved in the project agreed to participate in the evaluation, that is, 3 teachers of economics, 2 of accounting, and 3 of mathematics with statistics. During the course of the evaluation 2 of these teachers left the school. Their replacements also agreed to be part of the evaluation. These 8 teachers all participated in or responded to the interviews, diaries, and questionnaires.

At School X, 6 teachers taught the subjects in the project. All teachers agreed to be part of the evaluation and all received the same questionnaires.

Data Analysis

Depending on the nature of the data collected, a range of coding and analysis strategies were utilised to analyse the data. Quantitative data (questions that required a box to be ticked or a number circled or written) from the questionnaires and substudies were coded and entered into SAS data sets. Frequencies and/or means were produced for these data sets. Comparisons were made between the responses of different groups, that is, the responses of PNGHS and School X students to the same questions were compared. Comparisons were also made between the 2 years if the data were available.

Two main tests of statistical significance were used: t-tests for the comparison of means, and chi-squares for the comparison of proportions. In this report the phrases "more likely" or "significant" are used to indicate statistical significance. Only differences with a probability equal to or more significant than 0.05 are reported, that is, there is a 95 percent chance that the difference shown is in fact a reality and not due to chance factors.

Qualitative or open-ended data, such as the general comments written on questionnaires, were coded into categories and presented as frequencies. These coded categories were also compared between groups. If there were a small number of participants in an exercise, as in the case of the interviews with teachers, comments were grouped together and are presented as themes.

All tables, except for information on total response rates and means, are presented in percentages for purposes of comparison between groups. The total number from which the percentage is calculated is shown at the top of the table.

Due to rounding of decimals, multiple responses to some questions, and omissions in others, not all table percentages sum to 100 percent. Some percentages are calculated for only those who responded to a previous question, for example, the percentages for frequency of home computer use are calculated for only those who stated they had access to a computer outside school.

For the student questionnaires, the responses of 6th and 7th form accounting, and 6th and 7th form economics, students have been combined. Subject groups are not exclusive; some students were located in 2 or 3 groups as they studied more than one subject, therefore the overall numbers

in some tables or figures are increased. The inclusion of some students in more than one group is likely to lessen any between-subject effects. In addition to this, due to the sizes of the samples, results are often not significant between subject areas.

CHAPTER 2

TEACHER PERSPECTIVES

Introduction to Teacher Perspectives

The information summarised in this chapter was collected from 3 sources: questionnaires given to teachers at both schools at the start and end of 1995, interviews conducted with teachers at PNGHS during the course of 1995, and snapshot diaries completed over the course of 1995 by PNGHS teachers.

Teacher Profiles

The information presented below was collected from questionnaires given to teachers at both schools at the start and end of 1995. In total 9 teachers were surveyed at PNGHS at the start of 1995, including one of the teachers who joined in the middle of the year. At the end of the year 8 teachers were surveyed at PNGHS (this included the 2 teachers who had joined the PNGHS staff in the middle of the year). At the start of 1995, at School X, 6 teachers were surveyed, and at the end of 1995, 5 teachers.

Background Knowledge and Training of Teachers

Table 1 provides a summary of the background of the teachers in the project at PNGHS and School X.

Table 1

Profile of Teachers at the Start and End of 1995

Area	*PNGHS Teachers*	*School X Teachers*
Teachers surveyed at the start of 1995	9	6
Previous teaching experience	1 to 20 years	3 to 31 years
Prior experience in using computers in the classroom	0 to 7 years	1 to 4 years
Prior use of computers for accounting	Spreadsheets	Spreadsheets for most topics e.g., cash budgeting, journals, manufacturing
Prior use of computers for economics	Spreadsheets To display notes	Research using PCInfos
Prior use of computers for mathematics with statistics	Algorithm programs Computer simulation Graph drawing Spreadsheets Logo	Sequence and series Calculating terms Demonstrations Graphing
Start of 1995: knowledge of computing	4 basic 3 average 2 very good	3 basic 1 average/very good 2 very good
Access to home computers	5	3
Formal computing qualifications	2 teachers: 100 level computing class Wordprocessing certificate	2 teachers: Programming certificates
Teachers who had attended in-service IT training	7 teachers: 3 curriculum-related 4 general IT skills	4 teachers: General IT skills
Teachers with no IT training	1	2
Teachers surveyed at the end of 1995	8	5
End of 1995: knowledge of computing	2 basic 3 average 3 very good	2 basic 1 average 2 very good

As shown by table 1 teachers entered the project with a range of previous experiences. Some were seasoned IT practitioners, whilst others had little IT experience.

Teacher Attitudes to Computers in the Classroom

Included in the questionnaires given to teachers was a series of 15 statements on the use of computers in the classroom. Teachers were asked to respond to these statements using a 5-point scale with options ranging from "strongly agree" to "strongly disagree". Table 2 shows the percentage of teachers who chose the "agree" or "strongly agree" options. Data for the teachers who completed a questionnaire at the start and end of 1995 only are shown in table 2, that is, 7 teachers at PNGHS and 5 teachers at School X.

Table 2

The Percentage of Teachers Who Agreed/Strongly Agreed with Statements About the Use of Computers in the Classroom

	PNGHS Start 1995 N = 7 %	PNGHS End 1995 N = 7 %	School X Start 1995 N = 5 %	School X End 1995 N = 5 %
Computers are valuable tools to improve the quality of a student's education.	71	71	60	60
Working with computers in class distorts the social climate.	-	-	-	-
Using computers in class leads to more productivity in students.	-	29	40	20
Students are more attentive when computers are used in class.	29	16	60	40
I can well do without the aid of a computer in my class.	14	-	40	20
Computers help to teach more effectively.	71	71	40	20
My way of teaching is positively affected when using a computer for teaching.	43	100	20	20
Computers enhance students' creativity.	57	86	40	20
The achievement of students can be increased when using computers for teaching.	33	43	20	20
A computer is not suited for teaching purposes.	-	-	20	-
Children should begin to use a computer at an early age.	100	100	60	80
Using a computer in a classroom makes a subject more interesting.	71	71	80	60
Computers can only be useful in a few subjects.	-	-	-	-
The more use I make of computers in class, the less time I would have to concentrate on the curriculum.	57	28	40	20
Students should be kept away from computers.	-	-	-	-

Over the course of 1995 the opinions of teachers at PNGHS showed some changes. By the end of 1995 they were more likely to agree with the statement "My way of teaching is positively affected when using a computer for teaching". The opinions of teachers at School X did not change significantly over the course of 1995. At the start of 1995, when the opinions of teachers at the 2 schools were compared, there were no significant differences evident. At the end of 1995, when opinions were compared again, teachers at PNGHS were more likely to agree with the statements "My way of teaching is positively affected when using a computer for teaching" and "Computers enhance students' creativity". It appears that teachers at PNGHS experienced some positive shifts in attitude towards the use of computers for teaching over the course of the 1995 teaching year.

Getting To Know the Software and Hardware at PNGHS

Selecting the Project Software

Teachers who selected the software for their course were asked what they considered to be important criteria for the selection process. Suitability for the curriculum was rated as the most important factor, next was compatibility with the hardware, then availability and cost. One teacher mentioned user-friendliness as an important factor.

Familiarisation with the Project Software

Prior to the start of 1995, teachers at PNGHS spent from 40 to 200 hours familiarising themselves with the software and hardware to be used in the project. Two teachers had used the software previously for teaching. Most of this time was spent preparing resources and worksheets and familiarising themselves with the operating system in general. Only 2 teachers had received formal training on the software.

Teachers were asked to rate, on a 4-point scale, how comfortable they felt with their level of skill in using the project software and hardware. At the start of 1995, 5 teachers felt "okay" about using the software and hardware (2 also indicated that sometimes they felt "a bit uneasy"), 3 teachers felt "comfortable", and 1 teacher "very comfortable".

At the end of 1995 all but 1 teacher stated that they felt "comfortable" or "very comfortable" using the software and hardware available in the project.

At the start of 1995, 6 teachers stated that the software fitted easily into their planning process and classroom practice, 3 teachers said that the software fitted in some areas and not others. At the end of 1995 teachers held similar opinions.

Contacts

At the start of 1995 all teachers used resource people to help them with computing queries. All the teachers used other PNGHS staff as resource people, and in addition some teachers used a range of others including teachers at another school, people in industry, university or college of education contacts, and friends and relatives. About half of these contacts were initiated because of the project.

Dealing with Problems

At the start of 1995 teachers experienced a range of problems with the computer hardware and software, such as programs not running, printers not printing, and so on. Teachers solved some of these problems themselves but in most cases they needed to get help from another person.

At the start of 1995 teachers' views varied on the necessity of additional computer support. Five teachers thought the support systems available were adequate and 4 thought they were inadequate. Teachers' views on the adequacy of support systems did not change much over the course of 1995, with most teachers holding similar views at the end of the year. One teacher commented that the support the teachers gave to each other was productive. Most teachers were allocated 1 extra non-contact period a week for the project during 1995, but some indicated that this was not enough, or needed to be timetabled so that meetings with other project teachers were possible. Teachers gave suggestions of additional support that they would have benefited from including:

- assistance with the selection and purchase of software,
- training on teaching with computers in a particular curriculum area using the purchased software,
- more general training on the software selected,
- training on the hardware and networking, for example, datashows and the shared file,
- an adviser or technician attached to the project,
- the use of a home computer, and
- extra teaching staff in the classroom for the initial setting-up period of the project.

Interviews with PNGHS Teachers

The following section of this report summarises the information given by teachers during the 3 interviews conducted at PNGHS in 1995. A number of common themes emerged from these interviews. These themes concerned the process of setting up the project and teachers' views on the impact of this project on themselves, students, and students' learning.

Workload

At the time of the first interview in March 1995, most teachers stated that the project had increased their workload dramatically. Teachers found that they had not taken account of all necessary activities, for example, the time taken to prepare computer-based lessons. As the project was delayed initially (through supplier problems), teachers had less time to familiarise themselves with the software and plan lessons. Some teachers felt that the project had been imposed on them without satisfactory consultation. Most felt that the computers should have been in the school for at least a term before they were integrated into the classroom and that they were getting behind in the syllabus as the computer-based lessons were taking up more time than planned.

Some teachers had spent time developing resources from scratch, as there were insufficient prepared lesson plans available and most teachers were spending all of their in-school spare time sorting out computing issues.

> Non-contacts are spent basically getting this work sorted out . . . becoming more familiar with packages, doing the tutorial, setting up class exercises, just general preparation. It's a real problem . . . you see this room is used all the time so we don't get access to it, only at lunch time and after school. We have got an older MAC in the department which is hopefully going to be upgraded to one of those so that we can have the same.

Some teachers were spending considerable time looking at a range of packages to decide which one to buy. This was difficult for some teachers as they felt that they did not have the knowledge to be doing this type of exercise. For example, one teacher commented:

> It's one of the hardest things. There are a couple of big programs we really need to buy and I'm trying to decide on those - it's actually quite difficult which is why I haven't done it yet. I'm trying to get something that does what we want. There is nothing so far as I can find - not many other schools are using quite big commercial type packages and so I've found it very difficult to get information. . . . I don't want to buy them if they don't do what I want them to do . . . because you read about them and they say that they do certain things but when you try them out that might be different to what I thought they said they did. I'd quite like to get something that does everything that we want rather than doing some of the things.

In July 1995, at the time of the second interview, time to develop lessons, for software familiarisation, and for self-training was still an issue for most teachers. Some subjects had been affected by staff changes, which had placed an extra workload on teachers in those areas. Over all, the workload related to the project had lessened since the first term but was still greater than in previous years. Teachers' feelings about lagging behind the syllabus had lessened, as by the second term classes were running more to schedule. Some teachers were having to monitor the computer rooms before and after school so that students had access to computers to complete assignments; this added to workloads. For teachers new to the project, workload and training issues were not as great as for those starting initially, as students now had a reasonable level of computer competence and colleagues provided more support.

In October 1995, at the time of the third interview, most teachers were using computers for the development of handouts, tests, and worksheets. For some this had created an extra workload as they saw the benefits for themselves in being able to cut and paste tests and assignments, and the benefits for students if their subject notes were located on the shared file. Finding the time to explore existing software and develop new ideas was still an issue for most teachers, although most stated that their workload had returned to its previous level.

A review of the project was the major extra workload anticipated for the third term. This would involve teachers in each subject area working together to refine, enhance, or delete tasks they had used in 1995 and develop new tasks for 1996, for example:

> At the end of this year, well shortly actually, we'll review the whole year and all those sorts of issues to do with the computer room. It's just that there'll be more time, at the end of the year for us to get together . . . *[Looking at how you've used computers for each unit?]* Yes, and the order of teaching, and with the new

> curriculum, whether there's something more we can do with computers. Really just review everything we've done and decide whether it's worth carrying on, modifying, or introducing something new.

Some modification to the way that computers were introduced to students at the start of 1996 was planned; students were to be encouraged to regard computers as tools, rather than the main focus of a lesson.

Training, Skills, and Contacts

At the start of 1995 most teachers felt that they would have benefited from more initial support and training but were caught in a double-bind situation. Through lack of computing experience, they did not have the skills to identify their training needs. After some hands-on experience teachers were in a position to identify their needs more clearly. Some felt that they did not have enough technical knowledge to troubleshoot and deal with problems. Most teachers thought that ongoing training was necessary throughout the year.

Prior to starting the project, teachers' levels of computer literacy varied and therefore their needs in terms of professional development and training varied from those who felt no need for extra training to those who felt that they had been thrown in the deep end. The type of training required was not always available. Trainers did not have knowledge of the curriculum, combined with knowledge of the capabilities of the variety of software packages available for MACs, for example:

> Well what happened with the course we actually had was it didn't work successfully. . . . So to get the best out of what we are doing it's a case of doing it yourself. Well what I would actually want would be someone starting at form 5, not form 6 accounting, to look at the structure of one of the textbooks and actually work out a computing guide that you could apply to whatever software step by step so there is something that is written adapted to computers . . .

Teachers found it difficult to find colleagues in other schools to ask for advice, as there appeared to be very few schools running similar projects and often these schools were not using MACs.

Most support for teachers came from within the school from the computer studies department and the other teachers in the project. Most teachers felt that the project had strengthened their relationships with their colleagues as they relied on each other for help, ideas, and resources.

> Within school [teacher's name] is our computer expert and what she doesn't know about MACs isn't really worth talking about. She is our in-house support for professional development. We also have a computer technician who is wonderful, he is very accessible, very helpful and comes in a minute's notice. If there are any problems with the equipment he certainly comes in and sorts it out relatively quickly. He is also proficient with all the MAC applications and programs.

Most teachers were finding that the project presented them with new challenges and the opportunity to learn new skills.

At the time of the second interview most teachers had moved through the stages of computer confidence defined by Atmore (1995). That is, from a stage of uncertainty (How to get what you want? How to solve technical problems?), to discovery (confident use, realisation of what functions can be best used in the classroom), to promotion and integration of skills (transferring skills to other areas, teachers, and class levels). Teachers were now more confident about their computer skills and their ability to troubleshoot, and were passing on their knowledge to other teachers and class levels. Although most were promoting computer learning, most still felt that their knowledge was concentrated in particular areas and that there were still many skills they could learn, for example, graph drawing.

All teachers felt that the project had a positive impact on their professional development and they had learnt a variety of skills. Most were enjoying the new challenges that the project offered and felt that their relationships with their colleagues had developed as they shared resources and ideas. All teachers saw this collegial support to be a very positive outcome of the project. Some teachers had attended training in their own time. Most teachers thought that training was more efficient than learning from a manual and would have liked regular training updates to learn new skills.

At the time of the third interview, all teachers thought that the project was still having an impact on their professional development. For some, personal interest in computing had increased. Most teachers had not received any additional training for the project since the second term and all would have liked more professional development and training. Teachers' needs varied: some would have liked more instruction on existing software, general MAC skills, the shared file, the datashow, graphics, and databases. Others felt they had mastered these areas and were ready for the next stage of training in advanced graphics and new ways of presenting materials to students, for example:

> I think we're ready as a group, to go into a more advanced phase and I don't know whether we need an outside person to deliver something for us or whether we just need to have the time to pool all of our various ideas and work out where we're going next . . . learning more techniques with graphing and looking at different ways of delivering computer lessons and really challenging the students. The students have probably levelled off in terms of their expertise as well and I don't think we want them to flatten out. I want them to keep on learning, so it means we've got to devise new and different strategies and things. We need TIME!!

Teachers who had joined the school part way through the year would have liked more basic training on the software and operating system.

Half of the teachers interviewed were content with their level of computer competency, the other half felt that their level of competency was satisfactory but they still needed some up-skilling. All had increased in computer confidence during 1995. Some teachers mentioned that they would like someone to show them the full capabilities of their existing software rather than having to read through manuals. Teachers would like more contact with other schools to discuss how they were using computers in the classroom.

Software, Hardware, and Room Layout

At the time of the first interview, most teachers stated that computer problems were more likely to be due to hardware rather than the software. Common problems were stacked printer queues, accessing the shared file, the datashows not working as the OHPs did not provide enough light, and software locking. Initially, technical problems happened frequently, but teachers were learning how to deal with them. If teachers could not solve problems, students, a colleague, or someone from the computer studies department was asked for help, for example:

> For both classes the teachers have made the comment that they are working very much in a team situation and so they are in and out of each other's rooms all the time. [Teacher] made the comment to me this morning that Room X is like Charing Cross station, there are people coming in and out the whole time. And I find the same thing with Room X where I'm the only commerce person working with a set of maths people. The teachers are in all the time either printing out while my class is there or talking about a particular thing that has happened and what would you do to solve it. Learning skills from each other in that sense. So I think the maths department was the first to learn how to use shared files through the HOD computers, they passed it on to me and I passed it on to commerce that they knew this so we learnt it that way.

Finding software to suit specific subjects or topics was difficult. Teachers saw the needs of a school to be different from the needs of a business (for whom software is often designed). In a school environment software that completes tasks also needed to be able to teach these tasks. Teachers found that suppliers did not appear to be aware of the distinction between completion and teaching. Software developed specifically for school courses was seen to be very useful as it provided a learning trail and predeveloped worksheets, both of which reduced planning time.

Some teachers mentioned problems to do with the computer rooms, for example, overheating, lack of blackout curtains, small room size, and orientation of the computers. Some of these problems were due to the computers being located in classrooms that were not built for this purpose. Some teachers were concerned with the student-to-computer ratio, for example:

> I think that our 3 people to a machine is a too high ratio. . . . It's not comfortable to sit around peering at the screen for 3 people . . . the outside person . . . you can just see her mind go walk about and she's learning nothing. I think that I'd like the room organised differently but I can't see how you would do it safely. . . . A lot of my girls want to voluntarily do all of their note-taking on the computer now.

At the time of the second interview the shared file, printers, datashow, and unexplained screen freezes were still occasional problems, though less than in the first term. Reliable access to the shared file was the major remaining technical issue for teachers. The datashows were now working properly due to the purchase of new OHPs. Overheating in the computer rooms was still an issue.

PNGHS had purchased a number of additional software packages since the first term. One package still needed to be bought. The software that was acquired was functioning as expected.

At the time of the third interview, printers crashing and unexplained screen freezes were occasional problems for most, though less than during the first and second terms. Teachers rarely had problems that they or a student could not remedy. The technician was called in occasionally. The main technical issues in the third term concerned one datashow and a laptop, both of which had faults and were in the process of being repaired.

Some teachers mentioned that the layout of their rooms was still not ideal, and if class sizes increased in 1996, this could be more of an issue.

Resourcing

At the time of the first interview most teachers thought that the support and resources needed for the project, including those in the general community, had been underestimated, for example:

> I think we need another pair of hands in the room especially for those first 6 weeks. Whenever one of us inadvertently wanders into the computer room, they are swamped with people who just need some more help. So another body, a technician who is up in the other rooms, if he had been down in our classrooms, it would have been great because he knows a lot of the answers. It's not his role particularly to help students but I've noticed whenever I've had a class up there, if he's been in or I've invited him to come in he's - it's really good just to have that extra hand or a senior monitor or something.

Most teachers felt hampered by the lack of computers available outside the classroom for planning purposes. Having a computer in the classroom for teaching purposes was useful, but the computer rooms were used all the time for teaching. All thought that the provision of computers outside classrooms, for the purposes of planning, was vital for a project of this type. Although most teachers had home computers, some were IBM compatibles, not MACs. This therefore limited the amount of planning some teachers could do at home.

At the time of the second interview all teachers were still concerned about the lack of computers, outside the classroom, for planning and administration purposes. Teachers were using the computers in each other's classes in lesson time. This was not seen to be an ideal arrangement, though it did have some positive benefits.

All teachers still felt that extra allowances or non-contact periods were needed for planning, development, and training for the project. Some teachers felt that there had not been enough provision for training and not enough investment in teachers as opposed to hardware and software.

In October 1995, at the time of the third interview, 2 laptops for the purpose of planning and administration were made available to teachers. This had made a major difference to teachers; the ability to take the laptop home to plan in the evenings was viewed very positively. For example, when asked if there had been any differences to access to computers for planning since the arrival of the 2 laptops, one teacher said:

> Yes, huge difference that actually. I was a bit disappointed because for me it was really a year too late. I'd had to do most of the hard work where I had to carry one of those ones home and now with this you've just seen how easy it is and we just take it into a classroom, it's just great, so we're really appreciative of that but it also

> is easier for doing the worksheets and things I was mentioning before with other subjects. You're much more liable to do it because you know you've got access to it. . . . I'm much more likely because I work so much at home that I've thought, I wonder whether ANU Graph can do this. . . . I'm trying to put tests on the computer and things like that whereas I hadn't really done that in term 2.

Most teachers felt that they needed to spend time together to plan for and review the project. Although most teachers had an extra period set aside a week, these were at different times. In order to get maximum benefit from this time, co-ordination with other teachers in their subject area was necessary.

Some extra resourcing was needed for the project over the course of the year, financed from general school funds, for example, a better quality OHP. Another resourcing issue was the cost of paper the students used. These costs were covered by each department though some were considering a paper levy in 1996. Some teachers expressed concerns about overrunning their department budgets due to these unexpected extra costs.

Most teachers still felt that students benefited more from a 2:1 ratio of students to computers than a 3:1 ratio, for example:

> . . . to me it is still a problem having 3 students to a computer and I still find the physical set-up of the room in an ordinary classroom, it's not ideal and again, we might come up with a better set-up.

The main reason given was that in a pair both students are on task and can clearly see the computer screen; in a group of 3 it is easier for one student not to participate.

Students

At the time of the first interviews there was wide variation in the keyboard proficiency shown by students. Most teachers felt that some of the problems of the project would be lessened if all students had basic keyboard skills initially. Some students found it difficult to adjust to using computers, and teachers felt that it took longer than they planned to familiarise students. Those students who were already computer literate had an advantage, for example:

> Mine are quite positive now. It took a bit of working at it at the start. At the beginning of the year we had the ones who were already computer literate and the ones that it was completely new to them. For those ones that it was new [to] I got a few negative vibes. But we did notice that after about 4 weeks they are now quite used to working through a tutorial on their own and they do that a lot better than students in the past have done that. Because they are now used to what's involved and so now they know just to go to it and just get on with it.

Students were concerned about the Bursary examinations, as they could not use computers in these examinations, therefore teachers wanted to ensure that students could complete work manually.

Students were being used more as resource people, both in terms of presenting student work through the shared folder and using the datashow, and in terms of using their knowledge to solve computer problems, for example:

> One of the things the kids love is they love to be able to teach you something, to have the learning being two way. A lot of them have knowledge on the computer that I don't have and they love to help me. So that's been really good, I've always been close to the kids but I think we have established a closer rapport in my classes because of that.

At the time of the second interview teachers thought that students' computer skills and confidence had improved. Some teachers felt that students were spending more time on the computers in class time as their attitudes were more positive, other teachers thought that students' attitudes towards computers were generally neutral. Students were being used as resource people for technical issues and this had a positive effect on students' self-esteem. Students' concern over Bursary examinations had lessened considerably—teachers had not heard any more statements about the incompatibility of computers and exams. Students were spending more time out of class independently using computers (doing their projects and using the computer for assignments for other subjects).

In October 1995, at the time of the third interview, teachers reported that like themselves, most students regarded computers as an everyday part of the classroom. Some felt that students' skills had plateaued and therefore new challenges were needed. All teachers continued to use students as resource people for technical issues.

Students' concern over Bursary and computer usage had disappeared. No teachers had heard students expressing concerns about this issue even though the examinations were drawing nearer. Most teachers felt that 1996 would be less of a "learning curve" for students entering the project as many had been introduced to the computer software in 1995.

Learning and Assessment

At the time of the first interviews teachers noted that students were more concerned with the method of learning (via a computer) than the content. Some teachers were concerned that students were not learning the content of a lesson as thoroughly as they would have done in previous years, or were concerned that tutorial packages did all the calculations or thinking for students. Essentially, students were learning 2 subjects.

Teachers thought that students were benefiting from the project in a variety of ways. The major skills they thought students were acquiring were vocational skills (tools of the trade such as spreadsheeting), computer literacy, understanding of concepts, social and co-operative skills, and presentation skills, for example:

> Practical keyboard skills, development of independence (because once they begin to understand that the computer is actually a tool that is friendly and they are prepared to try things, I'm hoping that they will become more independent in thought).

Most teachers thought that students were interacting more and developing better co-operative and group skills than previously.

> . . . In terms of my subject they wouldn't normally be working so much in groups and helping each other. I found that the ones that knew the computers were helping the others and that whole idea that they don't ask me always as there are other girls in the class that actually know more about the computers themselves. So they have got that idea of asking different people.

Most teachers did not feel that the use of computers was likely to make any difference to grades on formal assessments such as Bursary. In 2 subjects students were required to do major projects using a computer. Teachers in one subject were going to consider the use of computers for assessment and testing in 1996.

In July 1995, at the time of the second interview, teachers were now focusing more on the content rather than the method of teaching. Some teachers were developing ways to get students to integrate theory and work on the computer, so that in mathematics and statistics students were asked to annotate graphs to show that concepts had been understood. This system was developed in response to concerns expressed earlier in the year about tutorial packages. In the first term teachers sometimes assumed that students were acquiring this knowledge automatically. Some now felt that integration skills are not necessarily picked up by default and need to be taught or monitored. Some teachers thought that the use of computers was expanding the possible variety of learning styles on offer to students, for example, visual learning through demonstrations.

Most teachers felt that students were becoming more independent and self-directed in their learning as they applied knowledge in more than one situation. Some thought that students were learning more as a result of the increased interaction between teachers, as computer tips were passed from one to another.

As in the first term, all teachers felt that students were learning important skills from participating in the project, such as computer literacy, vocational and life skills, self-teaching skills, problem-solving skills, and increased understanding of some concepts.

Some teachers felt that the depth and quality of students' project work was increasing—as the time spent doing the nuts and bolts (e.g., graph drawing) decreased, more time was left for analysis and interpretation. Most subjects did not include computer-based testing or examinations. Teachers in the subject where this did occur had developed a system to ensure equitable access to computers for all students during tests. Some teachers thought that doing assessments of this type using computers would disadvantage students who had fewer keyboard skills.

At the time of the third interviews, some teachers were challenging assumptions they held about how students learnt, for example, that analysis, editing (using spell check and cut-and-paste functions), and graph comprehension skills would be automatically acquired by students. Teachers were now giving students clearer instructions and guidelines about these activities.

By the third term most teachers required all assignments to be wordprocessed. In mathematics with statistics, teachers did not have this requirement, because of the large number of students, though students were encouraged to use wordprocessors and statistical packages for their internally assessed projects. Teachers gave a range of comments on the effect of using computers on students' internally assessed projects:

- All teachers thought that projects were well presented, neater, and easier to mark. Students took more pride in their work as they were able to present it more professionally.
- All teachers of mathematics with statistics thought that the analysis skills of higher achieving students were more developed. This was because the time saved on number crunching and drawing basic graphs was used for further analysis of data.
- Some accounting and economics teachers thought that some projects were more logically developed due to students taking advantage of the editing functions available on the computers. Others thought that less able students, or those with literacy problems, achieved at a higher level by using wordprocessors, for example:

> They take greater pride in their work . . . they've got the tool to present it well and they've accepted the challenge of taking advantage of that I guess. As the quality of presentations improved I think that their actually quality of work and the depth of work has improved. I think when you see a measly paragraph typed out and it only takes 3 lines, the impact is greater than a 10-line scrawl. . . . Often the less able girls, because they've perhaps come through the typing area, are more competent wordprocessors and I think the advantage of group work has had benefits in developing their confidence and sharing ideas. . . . So they actually have a greater resource now for doing their assignments. *[And what about the ones at the top, do you think it's pretty much the same for them?]* I think they're probably achieving at the same level but perhaps with slightly more legible presentation.

- Some noted that students fell into "computer traps", such as not spell checking and proofreading work, or setting defaults for their graphs.
- Some teachers of mathematics with statistics and accounting thought that students were getting more experience with real life situations and data through the use of computers for their projects.

All teachers thought that over the course of the year students had acquired a variety of skills as a result of using computers, or as a result of the environment that computers and group work had helped create in the classroom.

Teachers saw the acquisition of the following skills to be the major advantage of using computers:

- *Skills and knowledge:* All teachers thought that students had acquired general computer operation, wordprocessing, and spreadsheet skills as a result of participating in the project. Some thought that, as a result of using computers, students' knowledge of subject content had improved. Most thought that students were acquiring a more realistic sense of life in the workforce.
- *Achievement:* Half of the teachers interviewed thought that students' academic achievement (as assessed by Bursary examinations) would not be affected by the project, and some thought that the analytical skills of some students (mostly high achievers) might be improved. Most teachers thought that the other skills that students were acquiring were more important.
- *Learning styles:* Most thought that using computers expanded the range of possible learning styles available, especially through visual demonstrations and peer learning.

- *Classroom interactions:* Most teachers thought that using computers in groups encouraged more interaction in the classroom. An environment was created that allowed students to ask questions without feeling ignorant, as everyone was both teacher and learner, including the teacher, for example:

> I know they would in other subjects [interact more] but it's mixed them up a lot more, mixed up the class and they've worked with different people, not that we've done that on purpose, but they just tend to do that themselves. And realising that a lot of them have got the skills and not just the teacher, whereas traditionally that wouldn't have happened in our course.

- *Social development:* Most teachers thought that grouping students on computers forced students to deal with personality clashes and encouraged "loners" to participate. Most thought that students were acquiring more co-operative, negotiating, and group skills.
- *Study habits:* Most thought that students had more opportunity to engage in self-motivated study and revision. Computers were a help for students wanting to organise their revision notes, and for some subjects, for those who wanted practice on extra exercises. Some thought that the emphasis placed on the computers at the beginning of the year had inhibited students from developing good study habits and this was only rectified after the first exam.

Classroom Environment

At the start of 1995 most teachers thought that using computers as a teaching aid tended to change the classroom environment from being teacher-centred to student-centred, as students focused on the computer screen and each other rather than on the teacher at the front of the class. Some subjects (accounting and economics) already used group work (therefore the use of computers in groups reinforced and formalised existing teaching styles). Most teachers thought that the 3:1 student-to-computer ratio encouraged more group work than previously. For mathematics with statistics classes, a student-centred classroom was more of a change. One teacher described their situation as:

> . . . far less talk from the front. You still run ragged going round helping people. But maths is like that - so it's pretty busy. But you're moving from group to group and helping with areas they are having trouble with. There is less teaching from the front. There is still a bit but often there is none at all. Where as traditionally I would talk more from the front. But they [students] are much more motivated.

Teachers viewed this change as positive, as they considered that interaction with others was an important social skill for students to learn. As a result of the changing dynamics of their classrooms, most teachers saw their role changing from that of an instructor to a facilitator. Teachers thought that the interactions in their classrooms were more informal than in the past. Most teachers were developing new management techniques, such as stopping in time for all students to print their work:

> Same techniques really but in terms of management there is the additional distracter of the computer tool in front of them so you've got to teach them not to fiddle when you want to talk to them. . . . But in terms of management of my delivery of exercise work to the students that changed too. A lot of my teaching I actually do it on the teacher's machine on the datashow so I don't use the white board nearly as much as I used to. Students, through shared folder, or through disk, can actually provide me with their solution . . . now they can download their work on to disk, bring it up to me, and I can load it on to the datashow or to shared file. It's so much quicker it takes a matter of seconds - 2 minutes and you can have it done - whereas with the old way it would have been 5 minutes of the student writing it or taking the students' work to the photocopier. So the use of students as a resource is enhanced using computers which changes my teaching style a little bit. I love using the kids' work [as] they get a great deal out of having their own work used.

At the time of the second interview, all teachers thought that the introduction of computers had changed the structure of their classroom and that students were spending more time in group and co-operative learning situations. There was an extra step added into the equation for students working on the computer: if they had a problem they tended to ask other students first, rather than going directly to the teacher. Therefore most teachers felt that the dynamics of the classroom were changing in that students now saw the teacher as a content expert, but not necessarily as a computer expert. Students were gaining life skills from taking on the role of computer expert and teaching teachers. Teachers continued to see their role more as facilitators.

Most teachers thought that when students were working on the computer they were left with more time to help individuals. For some there was more one-on-one teaching as students were more accessible. This was a change from the first term when most felt that they needed more support in the classroom to help with the large number of queries. Now that students were familiar with the method, it freed the teacher to answer content queries.

Some teachers were developing new management techniques such as rotating the pairs who worked on the computers as they realised that some students were getting more keyboarding experience than others. Teachers were also liaising with each other to avoid overcrowding in the computer rooms by ensuring that major projects did not have the same deadlines.

At the time of the third interviews, most teachers indicated that the atmosphere in their classrooms had become more relaxed and informal. This was viewed as a positive change. Most found that students working around computers engaged in lively debates that were facilitated by the use of computer screens to display work. Teachers of mathematics with statistics felt that the dynamics of their classrooms had changed due to the use of computers for group work and the use of students as tutors. In other subjects there was less of a change, as co-operative learning was more common, though all teachers mentioned the increased diversity of roles it was possible for students to have as a result of the changed dynamics in their classrooms.

Lesson Planning and Computer Usage

At the time of the first interviews, most teachers were spending a lot of time planning resources for computer-based lessons. Most were finding it hard to calculate how long these lessons would take. Some textbooks included computerised lesson plans but they were not always in the same software

packages and therefore had to be adapted (as do text-based lessons). Accounting had computer exercises included in textbooks, but for the other subjects teachers had to develop this information themselves. For example one teacher said:

> Planning has changed in terms of getting everything converted to being computerisable. That's been a problem. We've got a set of books, but it uses Microsoft, so we can't give them straight exercises from this because they've got to change the instructions. Everything we do we've got to make sure it's able to be used in ClarisWorks and trial it. Normally if you have an exercise in a textbook you just tell the kids to do it. Well we've got to do it first and then either rewrite it, modify it, change the instructions or whatever and that takes time.

All teachers were sharing resource material to decrease the time spent planning. Teachers indicated that they were using computers as a tool to aid in the understanding of theory rather than to teach theory.

At the time of the second interview teachers varied in their approaches to integrating computers into the classroom. Some used computers to deliver lessons (through the shared file), and others used more traditional methods (whiteboard or textbook exercises). Some planned computer-based lessons, whilst others left the computers to be used as a tool. Some teachers were using computer software to teach theory; for example, computer demonstrations were used as a more concrete and visual way to explain theories as teachers thought that this would aid their students' understanding of concepts. Teachers of mathematics with statistics tended to use the computer as a tutor; accounting teachers tended to use the computer as a tool for wordprocessing and spreadsheeting; and economics teachers tended to use a combination of these two approaches. An increase in confidence meant that most teachers were willing to experiment using computers during a lesson (in the first term this would have had to be planned).

Some teachers thought their method of teaching was changing from inductive to deductive. Students could now be presented with hypotheses which they could prove or disprove using information from computer databases (previously students had been presented with a series of facts).

Both students and teachers had developed a more selective approach to assessing what was best done on the computer and what was best done manually. This was in contrast to the first term in which most teachers thought that they should try to use the computers as much as possible.

The way that teachers integrated computers into the classroom depended on a number of variables: the nature of the subject or the topic being taught, the capabilities and availability of the software, the level of computer competence and the personal philosophies of the teacher, and the other workload demands on the teacher.

At the time of the third interviews most teachers stated that they had not made any major changes to the way they planned lessons or managed classes since the second term. Some noted that they did not have to plan as fully, as they were familiar with the processes involved.

Some teachers were using the computers less in the third term because of pressures to complete courses and the nature of the topics they were covering. Most noted that they were slightly rushed in completing courses. Some teachers were revisiting areas that they felt students had not fully comprehended in the first term. At the end of the year, courses were completed in all subjects but

some teachers felt they had less time for revision than they would normally have preferred. Some thought that this could be partially attributed to the time taken to introduce computers at the beginning of the year.

Most teachers noted that by the third term students were more self-directed in their use of computers (in most classes some students took their notes on a wordprocessor). Students were also using the computers more for individual work. Like teachers, students had developed skills in selecting the work most appropriate for computers. In most classes, students used computers voluntarily for taking notes.

Most teachers had used the computer rooms for other class levels and planned to develop a more formalised system for access in 1996. Some found computer work with junior classes simpler to organise as there was no exam pressure, and concepts at a junior level were easier to explain and demonstrate, for example:

> Also, I'm definitely using and learning a lot more with the junior classes. I think the flow-on is actually greater at the junior level for me. I'm now spending about over half a term a year in the computer room with juniors, 2 or 3 weeks each term with junior classes. So I think that will flow into the subject at the senior level, they'll be more competent . . . their syllabus is more suited to doing individual assignments and projects.

Hints on Setting Up a Project

In the third interview teachers were asked what information or advice they would give teachers at another school setting up a project of this type.

- All thought that adequate training and ongoing professional development on the software and hardware was vital for teachers. Teachers needed to be throughly familiar with the systems before using them in the classroom. Some thought that it was better to "start simple" and be thoroughly familiar with a few software packages rather than focus on a large variety of packages.
- Most teachers thought that before starting a similar project, teachers needed to acquire as many resources and as much information as possible from others on areas such as suitable software for their course, operating systems, classroom planning for the addition of computers, computer worksheets and tutorials, techniques for managing students using computers, and so on.
- Most teachers commented that they would give other teachers the resources they had developed as a starting point.
- Most teachers thought that at least a 2:1 ratio of students to computers, and a computer outside the classroom for the purposes of planning, were necessary.
- Some teachers thought that having time set aside for all teachers to meet to discuss the project would be useful.
- Some noted that teachers needed to consider how to introduce computers to ensure that students maintained a positive attitude towards them. Another issue to consider was placing undue emphasis on computer skills at the expense of knowledge of subject content.

- Other suggestions given were: using the shared file to store as many lesson notes as possible, have a technician for solving major problems, and considering equipment and room layouts carefully.

As one teacher put it:

> To become totally familiar with the package and the whole system. *[Before they go into the classroom with it?]* Yes. And be aware that it is going to take a lot of their time to formulate new exercises and projects that you want them to work on. Probably to discuss how to organise the students, how one can work with the students working in groups and pairs and individually. To try and incorporate the computer skills through in every section that you do. Like having an exercise or task in every section that you do that will give the students access to the computers.

Snapshot Diaries

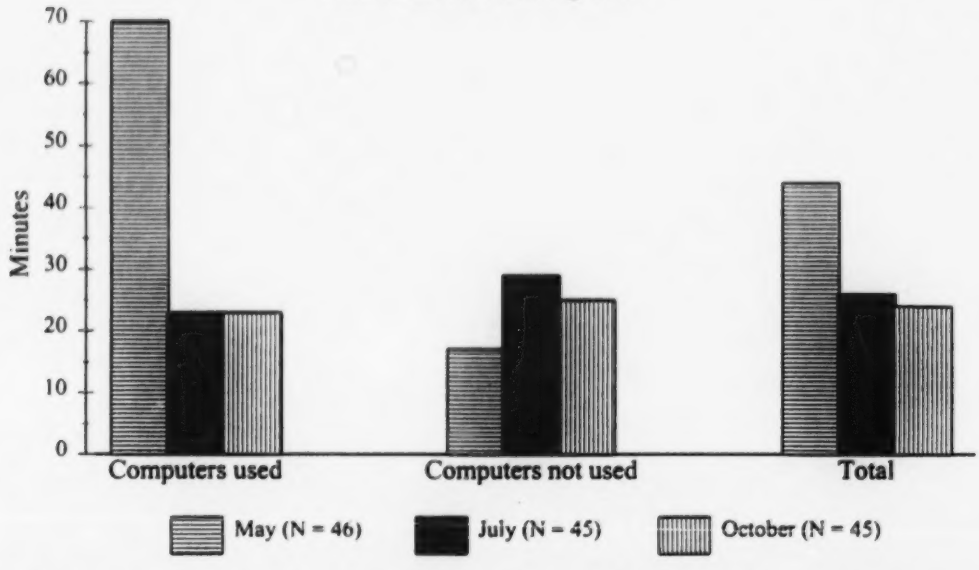
The following information is a summary of data collected from the snapshot diaries conducted in May, July, and October of 1995.

Time Taken To Plan Lessons

Over the course of 1995 the mean time taken by teachers to plan lessons (i.e., preparing resources and worksheets) decreased as shown by figure 3. Figure 3 also shows the mean lesson planning time for lessons in which computers were used and for those where they were not.

Figure 3

Mean Lesson Planning Time



In May teachers spent significantly longer on planning lessons in which computers were used. This increased workload was noted by teachers when interviewed. By July and October this

difference was not evident. (Note: It is necessary to be cautious when interpreting these figures as by July and October some of the computer use by students was voluntary, rather than planned, though the figures do give some indication of the initial workload involved in preparing exercises involving computers and computer tutorials.)

Lesson Organisation

Teachers were asked to specify what proportion of each lesson was spent using the organisation types shown in table 3. The mean percentage of time was then calculated for each type.

Table 3

Mean Occurrence of Lesson Organisation Type

Type of organisation	May N = 50 %	July N = 53 %	October N = 47 %
Teacher instruction of class	26	30	27
Students working in small groups on computers	30	18	13
Students working independently on computers	4	13	7
Students working independently off computers	18	20	34
Students working in small groups off computers	11	7	8
Student instruction of class	6	-	8
Other	5	11	2

Over the course of 1995 patterns of lesson organisation changed significantly. Students generally spent one-fifth to one-third of their time in class using computers, that is, 34 percent of their time in May, 31 percent in July, and 20 percent in October. The most common type of lesson organisation that occurred throughout 1995 was teacher instruction of the class. The proportion of time students worked in small groups on computers decreased over the course of the year, whilst the proportion of time students spent working independently on computers increased slightly. When interviewed, teachers reported a variety of reasons for the reported drop in computer use; for example, in October mathematics-with-statistics classes were not doing a topic that used computers, teachers were becoming more selective about what they were using computers for, and the Bursary examinations in the final term created pressures.

Use of Computers

Over the course of 1995 computers were used by students, at some stage, in approximately half of all lessons, that is, 50 percent of lessons in May, 55 percent in July, and 49 percent in October. For lessons in which computers were used teachers were asked to specify for what purposes as shown by table 4.

Table 4

Use of Computers

Type of computer use	May N = 23 %	July N = 30 %	October N = 25 %
Computerised tutorials	65	27	24
Note-taking	13	43	64
Working on teacher-selected exercises	48	52	28
Working on self-selected exercises	-	4	8
Working on projects or assignments	9	17	12
Other (tests, revision, etc.)	13	9	16

Over the course of 1995 the types of activities for which students used computers changed significantly from more structured activities such as tutorials, to more self-selected and independent work, such as note-taking and project completion.

Patterns of use also varied significantly between subjects as shown by table 5.

Table 5

Use of Computers by Subject

Type of computer use	Acc. N = 18 %	Econ. N = 38 %	Math. N = 22 %
Computerised tutorials	-	21	95
Note-taking	33	61	-
Working on teacher-selected exercises	55	29	41
Working on self-selected exercises	-	8	-
Working on projects or assignments	11	18	-
Other	7	13	5

Accounting students were more likely to use computers to work on teacher-selected exercises and for taking notes, for example, looking at the effect of accounting errors and their flow-on effects using spreadsheets, developing a flowchart for purchasing systems, answering questions on internal control, and note-taking and practical exercises on budgeting for small and large businesses.

Mathematics-with-statistics students were more likely to work on computer tutorials such as ANU Graph graphing and graph sketching. Other ways that computers were used in mathematics with statistics included looking at subjects such as hypothesis testing using Hypercard Mathematics with Statistics, and reviewing tests using solutions located in the shared folder and displayed on the datashow.

Economics students used computers for a range of activities, the most popular being note-taking, for example, completing worksheets loaded on to the shared file on the role of Government and the Lorenz curve; completing worksheets on inflation using data from MACGlobe and PCInfos; using

MACGlobe to extract data on developed and developing countries, and presenting these findings to the class via the teacher's computer and the datashow.

Motivation

Teachers were asked to rate how motivated students were during the course of each lesson. Table 6 shows the ratings recorded by teachers.

Table 6

Teacher Ratings of Student Motivation

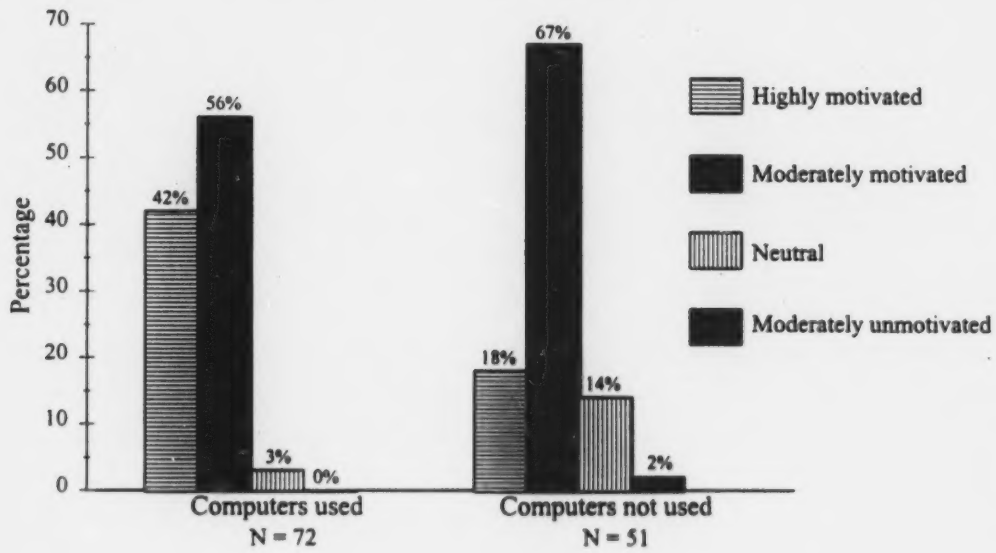
Rating	May N = 38 %	July N = 42 %	October N = 43 %
Highly motivated	29	33	33
Moderately motivated	61	60	60
Neutral	11	8	4
Moderately unmotivated	-	-	2
Highly unmotivated	-	-	-

There were no significant differences between months.

To provide a measure of the possible effect of computer use on student motivation, lessons where there was no student computer use were compared with lessons in which students used computers as shown by figure 4.

Figure 4

Student Motivation by Computer Use



Teachers were more likely to report that students were highly motivated in lessons where computers were used.

Lesson Focus

Teachers were asked to rate whether they thought each lesson was teacher-centred (where the teacher acted as an instructor) or student-centred (where the teacher acted as a facilitator) as shown by table 7.

Table 7

Teacher Ratings of Lesson Focus

Rating	May N = 38 %	July N = 42 %	October N = 43 %
Totally teacher-centred	16	7	2
Mostly teacher-centred	8	14	16
Dual focus	8	33	40
Mostly student-centred	26	24	35
Totally student-centred	42	24	9

In May, teachers were more likely to report that their lessons were student-centred compared to July or October. This difference is likely to reflect the greater computer use reported in May.

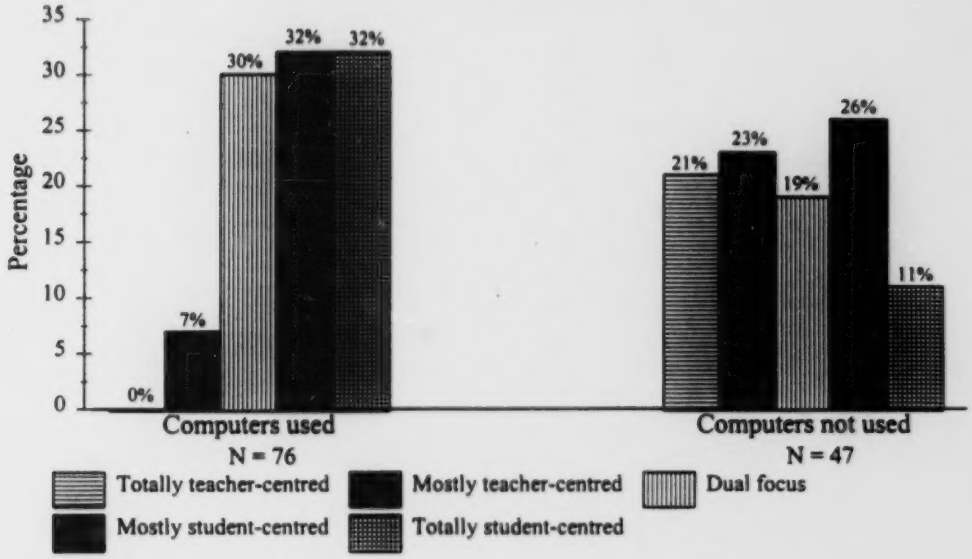
Teachers tended to rate lessons where they were returning and clarifying assessments such as examinations, tests, or projects as totally teacher-centred. Other activities that were rated as mostly teacher-centred included the introduction of topics such as hypothesis testing and stock valuation.

Totally student-centred classes often involved students working on researching and wordprocessing projects or assignments. Other activities that were rated as mostly student-centred included group work on computer-presented worksheets, and students taking notes, drawing graphs, or completing revision exercises from textbooks or computer databases.

Lesson focus was compared for lessons for which there was no student computer use, and lessons where there was student computer use as shown by figure 5.

Figure 5

Lesson Focus by Computer Use



Teachers were more likely to report that in lessons where computers were used, the focus was student-centred.

Assistance Required by Students

In total, on 58 percent of the record sheets in May, 53 percent in July, and 66 percent in October, teachers commented that assistance was required as shown by table 8.

Table 8

Assistance Required by Students

	May N = 29 %	July N = 28 %	October N = 31 %
Specific concepts in the lesson	45	75	90
The overall lesson plan	21	-	16
Software	48	14	3
Hardware	41	4	3
Other	-	14	3

Over the course of the year a changing pattern was evident. In May most queries reported were about computer software and hardware. By July and October student queries focused on the concepts being taught.

Technical Issues

In May, 26 percent of all record sheets contained notes on difficulties experienced. By July this proportion was 9 percent and in October no technical difficulties were reported. The majority of problems in May concerned printers and in July, accessing software, for example:

> Printing problems - at computer "end" connection loose. Fiddled with connections and reprinted okay.

> Again PCInfos proved a problem on some machines. Students shared information to overcome this.

Summary of Teacher Perspectives

The background of teachers in the project varied widely from those who were experienced IT practitioners to those who had very little computer experience or training, though most had experience using computers in the classroom. Teachers' viewpoints tended to reflect their level of previous involvement with technology. Teachers with more experience and training tended to feel more confident using computers and saw less need for additional resources and training. Those who had less experience felt the need for more help at the initial stages of the project. It appeared to be difficult for teachers to find training suited to their requirements. At PNGHS teachers' attitudes towards the use of computers in the classroom changed in a positive direction over the course of 1995.

At the time of the first interviews teachers were concerned about a number of areas:

- the delay in setting up the project,
- the perceived lack of support and resources available in the wider community, and
- the underestimation of (and therefore allowances for) the impact of the project on teacher workloads.

In the first term data from the diaries showed a high lesson-planning workload for lessons in which computers were used. Teachers experienced a range of technical difficulties with computer hardware and software. They reported that students were focused on learning computer skills, required assistance adjusting to computer hardware and software, and were working mostly on exercises directed by teachers.

Many of the issues mentioned in the first term had been resolved by the second and third terms. By the end of 1995 there was no difference in the time taken to plan computer and non-computer-based lessons, and technical difficulties were virtually nonexistent. In general teachers felt much more positive about their computer competence and the project as a whole, and by the third term, for most, computer use had become part of standard classroom practice.

By the end of 1995 students were focused on subject-based skills and using computers more independently. Computers were used by students at some stage in approximately 50 percent of lessons reported on, and patterns of use varied between subjects. Teachers reported increased student motivation and a move towards more student-centred classroom environments for lessons in which computers were used.

Even though there were problems for teachers in terms of workload, technical issues, and computer-to-student ratios, all teachers thought that the project was benefiting students, challenging them, and enhancing their computer knowledge and professional skills.

Teachers were planning a variety of improvements for 1996 such as additional training and the introduction of other class levels to computers.

Summary of Major Teacher Concerns

The major concerns of teachers over the course of 1995 were:

- *Workload:* The increased workload and the need for more time for planning, developing resources, and reflection was one of the major issues for teachers.
- *Training:* Most teachers thought they needed more initial IT training but had difficultly finding training that related specifically to their needs and subject areas. Most felt that training had been overlooked somewhat in favour of purchasing hardware and software.
- *Software:* The lack of available subject-specific teaching software for MACs was a concern for teachers.
- *Student access:* The student-to-computer ratio was an important issue for teachers who thought a 2:1 ratio was more beneficial than a 3:1 ratio.
- *Subject-specific concerns:* Computers appeared to be easier to integrate into some subject areas, for example, accounting used mostly wordprocessing and spreadsheets, and textbooks with computer-based exercises were already available. This was not the case for mathematics with statistics.
- *Student training:* Most teachers considered that the implementation of the project would have been smoother if students had been taught basic keyboarding skills before they started.
- *Leadership:* Staff changes during the course of the project altered the balance of teacher IT skills in the 3 departments. Having a staff member to act as a resource person aided the smooth functioning of the project. Some subject areas had more staff able to act as resource people than others.
- *School resourcing and support:* Investing in computer equipment was not a one-off purchase; additional and unplanned costs, such as extra paper, new OHPs, and computers for the purposes of teacher planning arose during the course of 1995. The need for the school to give more priority to teacher development and a resource person to provide technical help at the start of the project was an issue for teachers.

Summary of Major Changes for Teachers

The major changes that occurred over the course of 1995 for teachers were:

- A high initial workload decreasing over time.
- Increased confidence with hardware and software.
- Increased use of the project software for a range of planning purposes.
- Development of further professional skills and collegial support networks.
- The identification of training needs and the meeting of some of these needs.
- Changes in classroom dynamics with a move to more informal student-centred classrooms, which necessitated some changes in management styles and roles for teachers and students.

- A positive change in attitudes towards the use of computers for learning, including a refocusing of viewpoints on what and how students were learning from participating in the project, for example, increased acknowledgment of the effect that a change in classroom dynamics had on students' social skills and ability to work in groups.
- Related to the above, teachers began to develop ways to validate their views on students' learning and integration of theory.

Summary of Computer Integration and Learning

A number of themes emerged concerning how computers were integrated into the classroom including:

- The ways that computers were used varied between subjects, namely, as a tool in accounting, and as a tutor in mathematics with statistics.
- Over time teachers developed a pattern of more selective use of computers in the classroom, and made some changes to the way computer use was integrated into their lessons.
- Over the course of the year students became more independent in their use of computers.
- A change in perception by teachers and students, for example, viewing computers as the focus of a lesson changed to viewing computers as a tool that was part of general classroom practice.

A range of impacts on students' learning as a result of the use of computers and changing classroom dynamics was observed by teachers, including:

- The development of students' skills in a range of areas, for example, computer literacy, presentation skills, workplace skills, group work, peer tutoring, self-teaching skills, and problem-solving skills.
- Increased understanding of some concepts due to the greater range of learning styles available, for example, visual demonstrations.
- Increased student motivation in classes where computers were used.
- Increased range of roles possible for students as a result of changes in classroom dynamics.

The differences in motivation and in classroom management styles reported by teachers confirms other educational research on the effects of computers in classrooms, namely, that computer use promotes student-centred management styles (Lai, 1992; Watson, 1993) and increases student motivation (Watson, 1993; Gardner *et al.*, 1992).

Over all the main theme to emerge from the teacher questionnaires, diaries, and interviews is one of change for PNGHS teachers: that is, changes in dynamics between and among students and teachers; changes in perceptions towards the use of computers, how computers are integrated into the classroom, and the types of learning that can be facilitated due to their use; and changes in teachers' workload and professional skills as a result of participating in the project.

CHAPTER 3

STUDENT PERSPECTIVES

Introduction to Student Perspectives

Information was collected from students in order to provide baseline data on their experiences of computing prior to the project, and to provide an indication of whether there were any changes over time in their attitudes towards, or use of, computers. The information summarised in this chapter was collected from 2 sources: the questionnaires completed by students at the beginning and end of both 1995 and 1996, and the retention-rate information collected for students in the project in both schools.

Background Information on Students

Prior Use and Knowledge of Computers

Prior to entering the project in 1995 and 1996, students were asked if they had ever studied computing or attended a computer course. In 1995 the majority of students, 62 percent for PNGHS and 61 percent for School X, had. In 1996 the figures were 44 percent and 48 percent respectively. The majority had used computers at school with only 6 percent or less of students at both schools noting that they had not. Table 9 shows students' school use of computers prior to the commencement of the project.

Table 9

Students' Prior Use of Computers at School

	PNGHS Start 1995 N =154 %	PNGHS Start 1996 N = 99 %	School X Start 1995 N = 117 %	School X Start 1996 N = 128 %
Playing games	53	61	80	80
Doing homework	44	42	46	44
Accounting	17	16	23	2
Economics	19	28	40	29
Mathematics	10	25	54	63
3rd form computer studies	20	8	4	3
Other curriculum areas	14	30	14	23
Wordprocessing for assignments	16	2	11	4
Taking tests	10	5	12	5
Graphics and design	9	3	5	2
Library computers	4	3	4	6
Personal work	6	1	6	6
Other (e.g., at primary school, work)	5	-	3	-
Have not used a computer	5	6	2	2

The pattern of computer use varied between schools; students at School X were more likely to have used computers in mathematics, and for playing games. In general, students at School X were more likely to have used a computer in one of the project subjects, prior to the start of the project, compared with PNGHS students (School X, 1995, 74 percent; 1996, 72 percent. PNGHS, 1995, 34 percent; 1996, 54 percent). In 1996 significantly more PNGHS students (54 percent) had used a computer in a project subject compared with their 1995 counterparts (34 percent).

At the end of 1995, 68 percent of School X students had used a computer in at least one of the project subject areas and in 1996, 92 percent. Table 10 provides a summary of the areas in which students at School X had used computers.

Table 10

School X: Students' Use of Computers in School During the 1995 and 1996 School Year

	End 1995 N = 117 %	End 1996 N = 119 %
Accounting	15	38
Economics	19	16
Mathematics with statistics	45	53
Other subject areas	18	40
Doing assignments and homework	40	48
Other areas	8	15
Did not use a computer at school	18	2

At the end of 1996 School X students were more likely to indicate that they had used computers in a project subject compared with the start of the year and compared with their counterparts in 1995.

At the start and end of 1995 and 1996 students at both schools were asked to describe how much they knew in general about computers as shown by tables 11 and 12.

Table 11

PNGHS: How Much Do You Know About Computers?

	Start 1995 N =154 %	End 1995 N = 140 %	Start 1996 N = 98 %	End 1996 N = 87 %
Quite a lot	12	11	4	11
A moderate amount	56	67	68	68
Not very much	32	21	29	21
Nothing at all	2	1	-	-

Table 12

School X: How Much Do You Know About Computers?

	Start 1995 N =125 %	End 1995 N = 117 %	Start 1996 N = 126 %	End 1996 N = 119 %
Quite a lot	10	10	3	8
A moderate amount	50	62	57	62
Not very much	36	25	37	28
Nothing at all	3	2	2	2

Over the course of 1995 PNGHS students' self-assessments changed. By the end of 1995 students were more likely to say that they knew "a moderate amount" about computers. At the start of the year 1996, students were more likely to indicate that they knew "a moderate amount" about computers compared with 1995 students.

There were no significant differences between schools or between the self-assessments of students at School X, and the self-assessments of students at PNGHS over the course of 1996.

The Influences of Home on Students' Experiences of Computing

At the beginning of the year students were asked to describe their parents' attitude to computers. The majority of students at both schools described their parents' attitudes as positive as shown by table 13.

Table 13

How Would You Describe Your Parents' Attitudes Towards Computers?

	PNGHS Start 1995 N = 143 %	PNGHS Start 1996 N = 96 %	School X Start 1995 N = 111 %	School X Start 1996 N = 127 %
Positive	64	55	73	54
Neutral	33	35	26	36
Negative	3	10	1	10

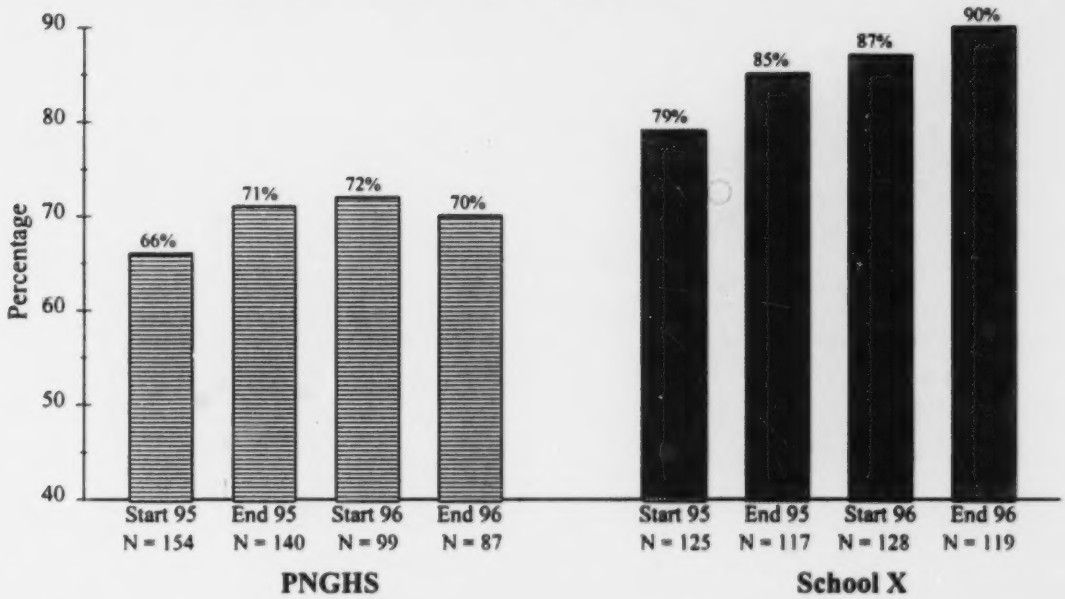
In 1995 students at both schools were more likely to describe their parents' attitude as positive compared with 1996 students. The majority of students at both schools stated that at least one of their parents used a computer at work. In 1995 parents of School X students were more likely to be using a computer at work.

To provide a means of comparison by socioeconomic status, students were asked what their parents' occupations were. Their responses were coded using a 1985 revision of the Elley-Irving Socio-Economic Index (Elley & Irving 1985); this information is located in appendix I.

At the start and end of 1995 students were asked if their family had a computer at home. The majority of students at both schools reported that this was the case as shown by figure 6.

Figure 6

Percentage of Students Who Had Access to a Home Computer

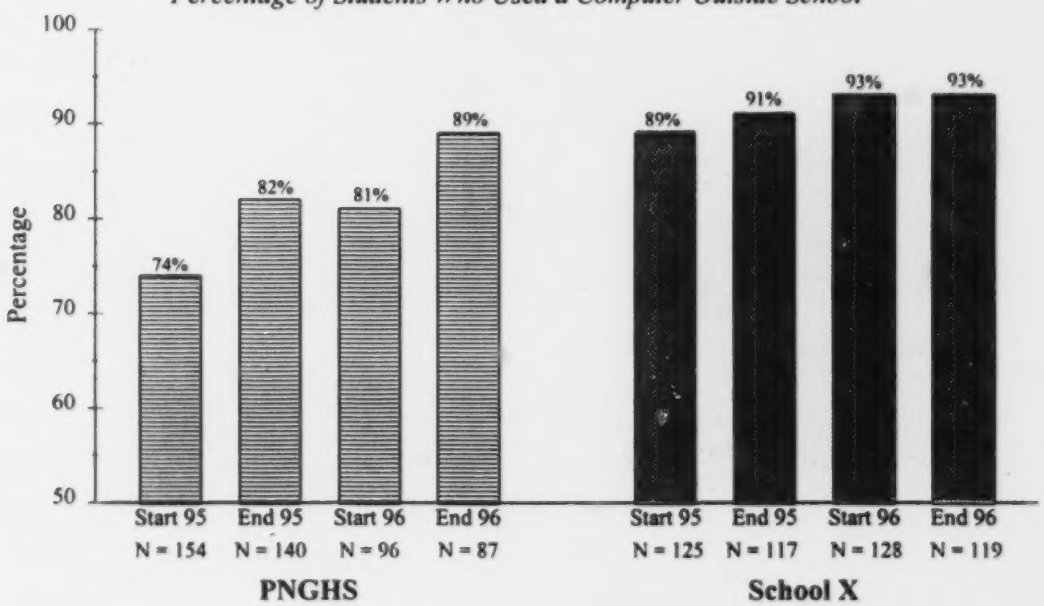


School X students reported a higher level of ownership of home computers compared with PNGHS students in both 1995 and 1996.

The majority of students used computers outside school as shown by figure 7.

Figure 7

Percentage of Students Who Used a Computer Outside School



At the start of both years students at School X reported significantly more usage of computers outside school than students at PNGHS. By the end of 1995 and 1996 students at PNGHS were using computers outside school in proportions closer to those reported by School X students.

Those students who used computers outside school were asked how often. Most students indicated that they used a computer occasionally as shown by tables 14 and 15.

Table 14

PNGHS: How Often Do You Use a Computer Outside School?

	Start 1995 N = 117 %	End 1995 N = 115 %	Change	Start 1996 N = 80 %	End 1996 N = 77 %	Change
Daily	10	6	-4	5	8	+3
4–6 times a week	6	4	+2	10	5	-5
1–3 times a week	19	37	+18	30	29	-1
Occasionally	58	50	-8	51	57	+6
Have access but do not use	9	3	-6	4	1	-3

Table 15

School X: How Often Do You Use a Computer Outside School?

	Start 1995 N = 111 %	End 1995 N = 106 %	Change	Start 1996 N = 119 %	End 1996 N = 113 %	Change
Daily	4	6	+2	8	11	+3
4–6 times a week	12	11	-1	14	15	+1
1–3 times a week	24	33	+9	25	27	+2
Occasionally	56	48	-8	47	47	-
Have access but do not use	4	2	-2	5	1	-4

During 1995 the pattern of use reported by PNGHS students changed. By the end of 1995 students were more likely to use a computer outside school 1–3 times a week. The pattern of use reported by School X students did not change significantly over the year, nor did the pattern between schools. There were no significant changes in 1996.

Students at both schools used computers outside school for a variety of purposes, the most common being for homework, wordprocessing, and computer games. In 1995 approximately one-third of the students who used computers did each activity on a weekly basis. In 1996 approximately 50 percent of students used home computers for wordprocessing and homework; this increase was only statistically significant for PNGHS students. Students at School X were more likely, in 1996, to use educational and reading software, and bulletin boards or the Internet compared with 1995 students.

Those students who had access to a computer outside school were asked if their parents encouraged them to use computers. Approximately half of the students at both schools indicated that this was the case as shown by table 16.

Table 16

Do Your Parents Encourage You To Use a Computer?

	PNGHS Start 1995 N = 117 %	PNGHS Start 1996 N = 79 %	School X Start 1995 N = 111 %	School X Start 1996 N = 119 %
Yes	56	52	44	45
No	4	1	2	3
Neither	39	47	54	51

In 1995 students at PNGHS were more likely to indicate that their parents encouraged them to use computers; there were no significant differences in 1996.

Most students did not spend time working with their parents using computers as shown by table 17.

Table 17

Do You Spend Time Working With Your Parents on Computers?

	PNGHS Start 1995 N = 116 %	PNGHS Start 1996 N = 79 %	School X Start 1995 N = 111 %	School X Start 1996 N = 119 %
Yes	30	41	40	35
No	70	59	60	65

There were no significant differences between or within schools for either 1995 or 1996.

Students' Attitudes

Students' Attitudes Towards Subject Areas

As a measure of students' interest and motivation, they were asked about their attitudes towards the subjects in the project that they were studying. Tables 18 and 19 show an analysis of students' attitudes across all subjects for both schools.

Table 18

PNGHS: Students' Attitudes Towards Subject Areas

	Start 1995 N = 213* %	End 1995 N = 191* %	Start 1996 N = 155* %	End 1996 N = 106* %
Positive	58	53	62	52
Neutral	35	38	33	48
Negative	7	9	5	8

* Note the total number of students is high as many students studied more than one subject.

Table 19

School X: Students' Attitudes Towards Subject Areas

	Start 1995 N = 172* %	End 1995 N = 159* %	Start 1996 N = 155* %	End 1996 N = 144* %
Positive	40	38	38	41
Neutral	44	43	41	28
Negative	17	19	21	31

* Note the total number of students is high as many students studied more than one subject.

PNGHS students were more likely than School X students to rate subjects positively. At the end of 1996 students at School X rated their subjects more negatively than at the start of the year.

Subject Continuation

Students were asked if they thought they would continue with the subjects they were studying in 1996. Tables 20 and 21 show the percentage of students studying each subject who thought they would continue with that subject at the start and end of the year.

Table 20

PNGHS: Students Wishing To Continue with Subjects

	Start 1995 N =154 %	End 1995 N = 140 %	Start 1996 N = 99 %	End 1996 N = 87 %
Continue with at least one subject	71	66	72	69
Continue with no subjects	29	34	28	31

Table 21

School X: Students Wishing To Continue with Subjects

	Start 1995 N =125 %	End 1995 N = 117 %	Start 1996 N = 126 %	End 1996 N = 117 %
Continue with at least one subject	55	62	64	64
Continue with no subjects	45	38	36	36

At the start of 1995 significantly more PNGHS students compared with School X students stated that they would be continuing with at least one of their subjects. By the end of 1995 this difference was still evident but no longer significant. There were no other differences between or within schools.

Computers in School and the Workforce

Students at both schools were asked whether they agreed, disagreed, or were not sure about a range of statements on computers in schools and in the workforce. Tables 22 and 23 show the percentage of students from each school who agreed with each statement.

Table 22

PNGHS: Students' Agreement with Statements on Computers in Schools and in the Workforce

	Start 95 N = 154 Agree %	End 95 N = 140 Agree %	Start 96 N = 99 Agree %	End 96 N = 87 Agree %
Everyone should learn to use a computer at school	88	91	80	91
It is more enjoyable to read a book than use a computer	31	36	21	22
Most school homework could be done easily on a computer	53	50	49	59
I would be comfortable using a computer in the workforce	68	70	63	74
I would like to use a computer more often at school	49	42	52	52
Schools should buy more computers	64	66	65	66
Doing school work by yourself on a computer is boring	22	15	15	14
I would like to have a job which uses computers	37	39	38	34

Table 23

School X: Students' Agreement with Statements on Computers in Schools and in the Workforce

	Start 95 N = 125 %	End 95 N = 117 %	Start 96 N = 128 %	End 96 N = 119 %
Everyone should learn to use a computer at school	86	92	83	83
It is more enjoyable to read a book than use a computer	32	42	35	40
Most school homework could be done easily on a computer	56	50	56	59
I would be comfortable using a computer in the workforce	74	73	73	73
I would like to use a computer more often at school	70	66	66	66
Schools should buy more computers	75	74	80	78
Doing school work by yourself on a computer is boring	18	14	14	18
I would like to have a job which uses computers	30	37	30	27

PNGHS students were more likely than School X students to disagree with the statement "It is more enjoyable to read a book than use a computer". In both years School X students were more likely to agree with the statement " I would like to use a computer more often at school", and in 1996 School X students were more likely to agree with the statement "Schools should buy more computers". It is likely that PNGHS students did not share the views of School X students as strongly on the frequency of use or purchase of computers at school as, due to their participation in the project, they had greater access to computers. There were no significant changes in students' responses, within either school, between the start and end of 1995 or 1996.

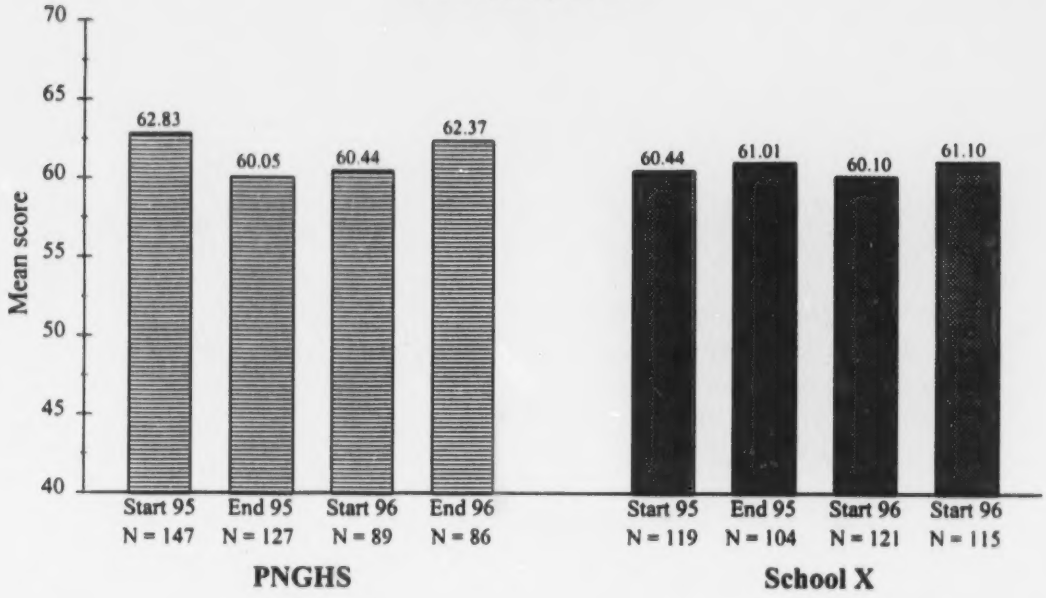
Anxiety Towards the Use of Computers

A 26-item computer anxiety index (CAIN), developed by Maurer and Simonson (1984),[1] was included in questionnaires given to students at both schools at the start and end of both years. On this scale a high score indicates a greater level of anxiety towards computers than a low score. Figure 8 shows students' mean scores.

[1] Simonson *et al.* (1992) define computer anxiety as "the fear or apprehension felt by an individual when using computers, or when considering the possibility of computer utilization". The authors state that the CAIN was developed in response to the observation that students who are anxious about computers have difficulty in acquiring computer competencies. They reported that when anxiety is reduced, achievement tends to improve.

Figure 8

Mean Anxiety Scores

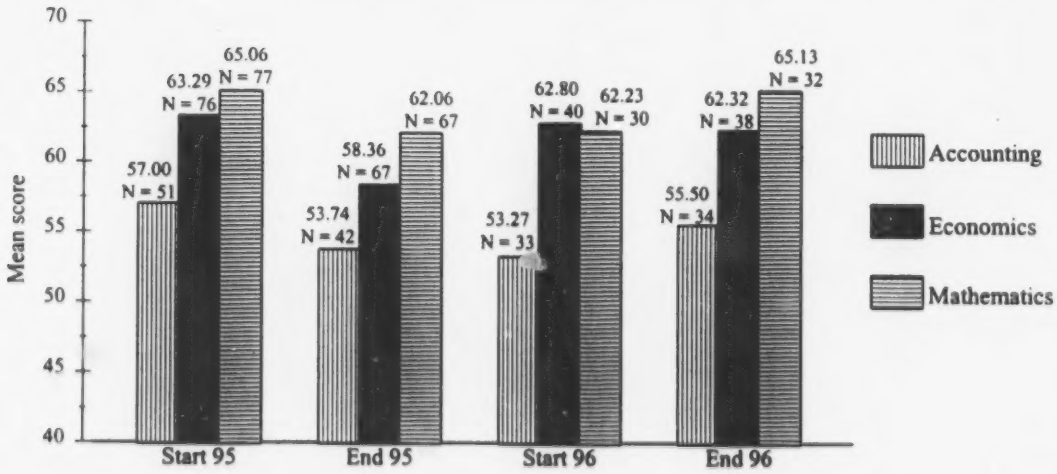


During 1995 anxiety levels decreased significantly at PNGHS and increased slightly at School X (though this change was not significant). Over the course of 1996 anxiety levels increased at both schools though neither change was significant. When the means of the 2 schools were compared with each other there were no significant differences at the start or end of either year. The 2 cohorts of students were also compared, but there were no significant differences at either school between students who started the project in 1995 compared with those started in 1996.

The levels of anxiety at PNGHS varied between subjects, as shown by figure 9.

Figure 9

Mean Anxiety Scores by Subject at PNGHS



Students of mathematics with statistics recorded a significantly higher level of anxiety in 1995 compared with students studying accounting. There were no significant differences between other subject combinations. Over the course of the year anxiety levels decreased in all subjects at PNGHS, though not significantly. The level of the change may reflect the frequency of computer use in each subject area, that is, mathematics with statistics shows the smallest change and was the subject where computers were used for the least amount of course work.

There were no significant changes in anxiety levels within subjects over the course of 1996. Anxiety levels decreased slightly for students studying economics and increased slightly in the other 2 subjects. As in 1995, students studying the subject in which computers were used the least showed the most anxiety. Economics students recorded a significantly higher level of anxiety at the start of 1996 compared with students studying accounting and, at the end of 1996, so did students of mathematics with statistics. There were no significant differences between other subject combinations.

Comparison of Students with High and Low Anxiety

In 1995 in order to develop a profile of the typically "computer anxious" student at PNGHS, and to look at factors that were associated with anxiety, the responses of the 25 percent most anxious and the 25 percent least anxious students were compared. Students with high computer anxiety were more likely to:

- have negative attitudes towards their subjects over all,
- report that their parents had neutral or negative attitudes towards computers,
- report that they had not used the skills they had learnt in the project in other areas,
- feel that there were more disadvantages in using computers in their subject(s),
- report that they did not know much about using computers, and
- use a computer less often outside school.

Factors that showed no significant relationship with computer anxiety were:

- home ownership of computers,
- access to a computer outside school,
- parental socioeconomic status, and
- parental encouragement of computer use.

Students' anxiety levels appeared to be influenced by both school and home variables. Students with lower levels of anxiety were more likely to see advantages in learning with computers, more likely to transfer skills they learnt in the project to other areas, and more likely to use a computer at home. Given these factors, it seems desirable for students to have low anxiety levels. Although most students had a home computer, this only impacted on anxiety levels if the computer was used regularly.

It appears that decreases in anxiety in 1995 may have been achieved if students had more computer experience before they entered the project. This conclusion appears to be supported by the 1996 data. In 1996 students reported that they already knew a moderate amount about

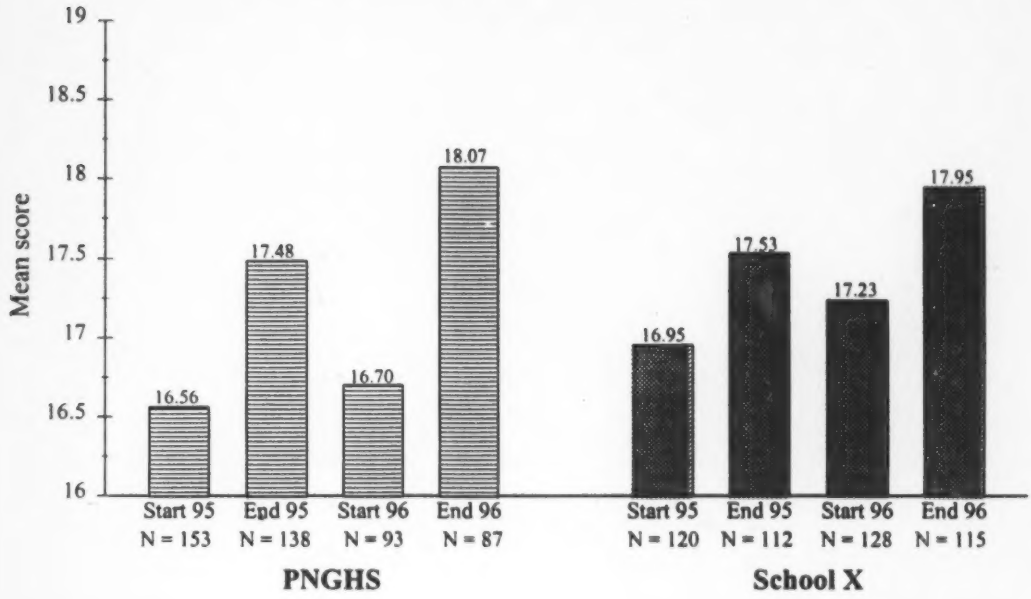
computers before entering the project and reported more use of wordprocessing packages at home compared with their 1995 counterparts. In 1996 anxiety levels did not change significantly.

Knowledge of Computer Terminology

All questionnaires included a test that focused on students' knowledge of computer terms. This test had a total possible score of 20. Figure 10 shows the mean scores for students at both schools at the start and end of 1995 and 1996.

Figure 10

Mean Knowledge of Computer Terminology Scores



The initial means, for students from both schools, were high, indicating that students were already reasonably conversant with computer terminology. Over the course of 1995, knowledge of computer terminology increased at both schools, though this increase was statistically significant only for PNGHS. In 1996, as in 1995, the initial and final means for students from both schools were high. Over the course of 1996, knowledge of computer terminology increased significantly at both schools, though more so at PNGHS. There was no significant difference in knowledge of computer terminology between schools either at the start or end of either year. Data from the 2 schools were compared over the 2 years. There were no significant differences between the 1995, or the 1996, cohorts at either school.

Tables 24 and 25 show the results of the test of computer terminology by subject at PNGHS in 1995 and 1996.

Table 24

Knowledge of Computer Terminology: Mean Scores by Subject at PNGHS in 1995

	Start 1995			End 1995			
	N	Mean	s.d.	N	Mean	s.d.	Change
Acc.	53	16.11	4.38	45	17.44	3.45	+1.33
Econ.	79	15.91	4.29	71	16.94	3.03	+1.03
Math.	80	17.58	3.42	73	17.93	3.61	+0.35

The means for all subjects increased during 1995 though this was significant only for economics. At the start of 1995 students of mathematics with statistics exhibited a significantly higher level of knowledge of computer terminology compared with economics or accounting students. By the end of 1995 any differences were no longer significant. There were no significant differences between economics and accounting students either at the start or end of 1995.

Table 25

Test of Computer Terminology: Mean Scores by Subject at PNGHS in 1996

	Start 1996			End 1996			
	N	Mean	s.d.	N	Mean	s.d.	Change
Acc.	35	17.77	1.91	34	18.12	2.50	+0.35
Econ.	42	15.93	4.35	38	17.63	2.84	+1.70
Math.	33	16.82	4.70	33	18.39	2.29	+1.57

The means for all subjects increased during 1996, significantly so for economics and mathematics with statistics. At the start of 1996 accounting students exhibited a significantly higher level of knowledge of computer terminology compared with economics students. By the end of 1996 this difference was no longer significant. There were no significant differences between other subject combinations.

Summary of Anxiety and Knowledge of Computer Terminology Data

In the first year of the project, students' anxiety towards computers decreased and their knowledge of computer terminology increased. In the second year, students' knowledge of computer terminology increased, but in contrast to the first year their anxiety levels initially were at a lower level and increased slightly over the course of the year. One possible reason for this variation is that the students in the 1996 cohort had more exposure to computers than the 1995 cohort, both at school and at home, and therefore had less initial anxiety towards computers.

Students' Views on the Project

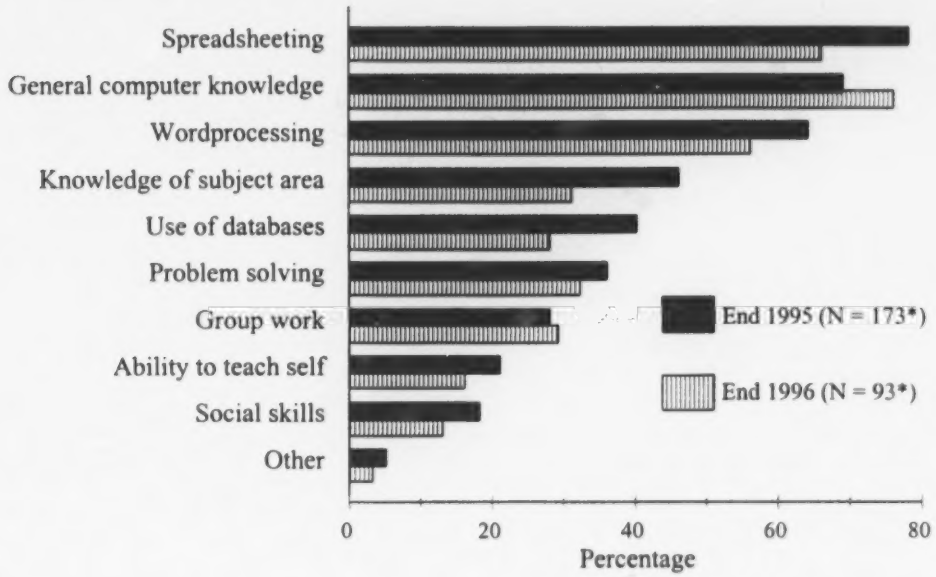
Skill Acquisition

Students at PNGHS were asked if they thought they had acquired any skills as a result of using computers in the 3 project subjects. In 1995 and 1996 the majority of students (76 percent and 82 percent respectively) indicated that they had.

When these figures were separated by subject, in 1995, 87 percent of accounting, 82 percent of economics, and 72 percent of mathematics with statistics students thought they had acquired skills as a result of using computers. The figures for 1996 were 82 percent, 87 percent, and 79 percent respectively. The skills that these students indicated they had acquired are shown in figure 11.

Figure 11

Skills Acquired by PNGHS Students as a Result of Using Computers in the Project



* Note: some students studied more than one subject and therefore are recorded more than once.

Most commonly mentioned across all subjects and between both years were general computer knowledge, and spreadsheeting and wordprocessing skills. There were no significant differences between subjects in either 1995 or 1996 though the patterns that emerged tended to reflect the ways that computers were used within each subject area; accounting students tended to mention spreadsheeting skills, economics students wordprocessing, and mathematics with statistics, general skills.

Use of Computers in Other Subject Areas and Transfer of Skills

The majority of PNGHS students stated that they had used skills learnt in the project in other subject areas (1995, 51 percent; 1996, 60 percent). The most commonly used skills were wordprocessing

(1995, 79 percent; 1996, 32 percent) and spreadsheeting or graphing skills (1995, 28 percent; 1996, 33 percent). (In 1996 fewer students mentioned that they had used wordprocessing skills in other subject areas. This is likely to be due to the increased use of wordprocessing software reported by students prior to entering the project.) Other areas mentioned by students were general computer and database skills, group work, and skills used in work outside school.

Computers and Learning

At the end of each year students at PNGHS were asked to agree or disagree with a list of statements on computers and learning in the classroom. Tables 26 and 27 show their responses.

Table 26

PNGHS End 1995: Students' Opinions on Statements on Computers and Learning in the Classroom

	N = 140		
	Agree %	Not sure %	Disagree %
The computer helps me correct my work	71	18	10
I can do most work on the computer without any help	66	23	10
I like computer work better than written assignments	49	29	22
Computers make my subjects more interesting	47	31	21
Computers help me to write better	45	27	27
Computers make lessons more interesting	42	36	21
I learn a lot on the computer	39	39	21
I have to hurry when I work on the computer	30	24	36
Computers help me to understand the subjects I am doing	20	45	34
I need a lot of help when I am working on the computer	20	23	56

Table 27

PNGHS End 1996: Students' Opinions on Statements on Computers and Learning in the Classroom

	N = 87		
	Agree %	Not sure %	Disagree %
The computer helps me correct my work	76	15	9
I can do most work on the computer without any help	61	21	18
I like computer work better than written assignments	53	30	17
Computers make my subjects more interesting	48	31	21
Computers help me to write better	48	17	34
Computers make lessons more interesting	46	30	24
I learn a lot on the computer	55	38	7
I have to hurry when I work on the computer	21	26	53
Computers help me to understand the subjects I am doing	13	40	47
I need a lot of help when I am working on the computer	28	24	48

The majority of students at PNGHS thought that computers helped them to correct their work and they could do most work on a computer without any help. Approximately half preferred computer work to written assignments. Students were divided as to whether computers helped them with the learning of subject content, though almost half thought that computers made their subjects and lessons more interesting. The 1996 students were more likely than 1995 students to agree with the statement "I learn a lot on the computer".

Advantages and Disadvantage of Learning with Computers

Students were asked if they thought there were more advantages or disadvantages in learning with computers in the 3 subjects in question. Although the level of access to computers varied between schools, students at both schools held similar views; at PNGHS in 1995, 45 percent of students thought there were more advantages, 38 percent were neutral, and 17 percent thought that there were more disadvantages. In 1996 the figures were 56 percent, 33 percent, and 10 percent respectively. At School X the figures in 1995 were 52 percent, 38 percent, and 10 percent, and in 1996, 56 percent, 36 percent, and 7 percent. Table 28 shows PNGHS students' opinions presented by subject.

Table 28

PNGHS: Advantages or Disadvantages in Learning with Computers

	More advantages %	Neutral %	More disadvantages %
1995 Acc. N = 46	57	39	4
1996 Acc. N = 34	71	21	9
1995 Econ. N = 71	48	38	14
1996 Econ. N = 38	66	34	-
1995 Math. N = 74	35	37	28
1996 Math. N = 33	30	45	24

Economics students in 1996 were more likely to think that there were more advantages in learning with computers compared with 1995 economics students. In 1995 accounting students, and in 1996, accounting and economics students, were more likely to think that there were more advantages to learning with computers compared with mathematics with statistics students. It is likely that this is due to the nature of the subjects in question; accounting involves spreadsheet work which is easily translated into a computerised format. This is not the case for mathematics with statistics.

PNGHS students were asked to describe the main advantages and disadvantages of learning with computers. In 1995 and 1996 similar proportions of students listed advantages (1995, 73 percent; 1996, 78 percent) and disadvantages (1995, 71 percent; 1996, 63 percent).

Advantages of Using Computers

The comments made by students on the advantages of using computers were coded into the categories displayed in table 29.

Table 29

PNGHS: Advantages of Learning with Computers

	End 1995 N = 102 %	End 1996 N = 68 %
Acquiring general computer skills	38	38
Saving time	34	40
Acquiring spreadsheet/graphic skills	23	21
Acquiring wordprocessing skills	17	4
Improving presentation	16	29
Access to database/subject-based information	15	7
Assists learning	12	22
Group work	4	-
Other	5	3

Students across the 3 subjects seemed to be in agreement as to the major advantages of using computers; these are the general computer skills they had acquired, the time saved when work was completed on a computer, and the spreadsheeting and work-presentation skills they had acquired. The following are examples of students' comments:

1995 It creates variety in a lesson. It is easier to locate information—especially in economics. Spreadsheets are easier to use when presenting accounting information.

With programs such as StatView student, ANU Graph, Models 'n' Data, statistics has become easier to understand through the illustration of graphs, etc.

Time is shortened for getting things done quickly, easy to relate to, gives skills for the workforce.

1996 Processing written material becomes faster and more efficient. Graphs and data tables are easily produced. The overall presentation of work improves.

Fast, accurate, can change things easily. Neat presentation of work. Calculation done very quickly. Enhanced computer knowledge.

Have visual stimuli, saves time when working through calculations.

Disadvantages of Using Computers

The comments made by students on the disadvantages of using computers were coded into the categories displayed in table 30.

Table 30

PNGHS: Disadvantages of Learning with Computers

	End 1995 N = 101 %	End 1996 N = 55 %
Time consuming	40	24
Learning how to use software	23	22
Not enough access to computers	16	11
Computers do all the work	23	16
Software/hardware problems	6	18
Lack of computers in exams	10	4
Lack of typing skill	12	11
OOS/eye strain	2	2
Other	3	11

Students' thoughts about the disadvantages of computers were not as clear cut as their thoughts on the advantages. Interestingly, the major disadvantage was the converse of the major advantage,

with students stating that working on computers often took up a lot of time. In both years opinions varied between subjects: accounting students were concerned about time issues and access to computers; economics students were also concerned about time as well as learning how to use the software and their lack of wordprocessing skills. For students of mathematics with statistics the main disadvantages were initial difficulties with learning how to use the software and that the computers were doing all the work for them. The following are examples of students' comments on the disadvantages of working with computers:

1995 Stats—you don't get to see the main processing part of the question.

When you have to do half a test on the computer (i.e., in accounting) people like myself are disadvantaged because we can't touch type and therefore do not have enough time to complete the task so we loose marks. There is not a computer for each person and it can be awkward with 3 people using the same computer. More time consuming because typing is slower than writing.

Not enough time spent on class work.

1996 A lot of calculations and other things are done automatically for you. You don't learn how to do it yourself without the aid of a computer.

General computer problems (e.g., won't open some files, the mouse malfunctions, problems occur when saving, problems with disks). Some people can't type very fast or accurately so it takes them longer than by hand.

Takes time away from class time, as when you are on the computer you have the added difficulty of computer. **Computer skills aren't tested in Bursary.**

Students' Comments

The final question in questionnaires at the beginning and end of both years for both schools asked students if they would like to make any general comments on the use of computers in the classroom. At the start of 1995, 46 percent of PNGHS and 48 percent of School X students made comments. For the start of 1996 the figures were 37 percent and 46 percent. For the end of 1995 the figures were 41 percent and 32 percent, and for the end of 1996, 33 percent and 50 percent respectively. Students' comments were coded into the categories shown in tables 31 and 32.

Table 31

PNGHS: Students' Comments on Computers in the Classroom

	Start 1995 N = 71 %	End 1995 N = 57 %	Start 1996 N = 37 %	End 1996 N = 29 %
Students need more access/training on computers	37	26	46	45
General positive comment on the use of computers	53	61	27	52
General negative comment on the use of computers	14	18	14	7
Computers slow things down	18	4	14	-
Comment on adjusting to using computers	14	-	16	3
Lack of computers in bursary assessment	13	12	5	7
Miscellaneous	4	16	5	7

Table 32

School X: Students' Comments on Computers in the Classroom

	Start 1995 N = 60 %	End 1995 N = 37 %	Start 1996 N = 59 %	End 1996 N = 60 %
Students need more access/training on computers	68	65	78	73
General positive comment on the use of computers	12	16	7	15
General negative comment on the use of computers	7	24	17	15
Computers slow things down	3	-	-	3
Comment on adjusting to using computers	-	-	-	2
Lack of computers in bursary assessment	-	-	-	2
Miscellaneous	13	5	7	10

The comments of PNGHS and School X students reflect their different priorities. Students at School X were more likely to state that students needed more access and training on computers. Students at PNGHS also commented on training and access but were less likely to make these types of remarks as they already had a higher level of access to computers. Students at PNGHS tended to make general statements about the use of computers for example:

Start of 1995, PNGHS

> A good idea, as computers are an inevitable part of this generation's future, as long as the teaching also remains focused on teaching us how to work things out for ourselves, as there are no computers in exams!!
>
> Takes a lot of time away from theory in the classroom—computers aren't going to be 'tested' in exams. Not enough computers (3 people to a computer—takes longer and 1 person might do all the work). Inconvenience—school computer is an 'Apple'

and home computer is an IBM. Can't do homework, hard to finish assignments if it's on a computer because then you have to finish it at school and if it is not finished in class time must do over lunch time.

Start of 1996, PNGHS

It is good to learn basic computer skills, because most of the time, in the workforce, people come across computers at some time.

Generally aids school work—helps in drawing graphs. Easy to use programs but teachers should instruct with only one system instead of two or three.

End of 1995, PNGHS

Thanks for the opportunity to participate in this computer orientated programme. My knowledge and that of my classmates has greatly increased throughout the year. I look forward to the continuation of the programme next year and personally believe it was a great investment in secondary education as computer skills are so important in today's workforce.

Although their use is beneficial for fast use of graphs and spreadsheets the time it takes up for students to learn to use the programs themselves without applying subject questions uses up limited time needed to learn the core part of the subject. Training for efficient computer skills should be offered before course work is started.

End of 1996, PNGHS

We should use them as often as possible, because computer technology is the future. But we need to be taught properly from the beginning. Perhaps a compulsory computer course is necessary in schools.

Computer skills are a valuable asset to the user BUT it is not a component of assessed work therefore the time taken to learn to use a program is not accredited to your final mark. In many sections of statistics work it would be quicker and more environmentally friendly (won't waste paper) for examples to be taught manually on the board.

Start of 1995, School X

I think computers in classrooms are important because of the importance of computer literacy in the workplace.

The computers we use could be new (i.e., not 20 years old). We could be taught how to properly use them—so when we go out in the 'real world' we do actually know how to use a computer.

Start of 1996, School X

> It would be really neat if we had more computers in our school, as they are becoming more and more important in everyday life, and many students' families cannot afford them, so it would be neat if they could learn more about them from school.
>
> Students should be taught how to use programs like Windows 95 otherwise they will fall behind when they reach the workforce. Also students should be taught to gather information from the Internet.

End of 1995, School X

> I think that there should be an increase in teaching how to use computers at school—because you need to be able to use it for the future, work, etc. I also think that instead of having so many different types of computers there should be a standard type so it isn't complicated.
>
> I feel better software is needed if computers are to be used in the classroom. It needs to interest everyone in learning.

End of 1996, School X

> I have had very little experience with computers at school which I think is a real pity. I expect that computers will play an important role in the workplace. So I think these are skills I should have learnt. I similarly think that computers can aid what we do in the classroom, but unfortunately we have not used them and not benefited from what they can bring to learning.
>
> Computing should be taught in a way that is not intimidating and by teachers who understand how to use them. The computers should not be outdated and the 'computer room' atmosphere should not be sterile and uninviting. Instead of teaching students only the paths they need for certain tasks they should be given general instructions so they can use other programs etc., on their own. Don't teach me let me learn!!

Retention Rates

Retention rates for the project and in total were collected from the 2 schools to provide a possible measure of students' interest and motivation in project subjects. Tables 33 and 34 show the numbers of students in the project, and in total at both schools, for the start and end of both years. Figure 12 shows the retention rates for students in the project and in total at both schools over 1995 and 1996. These retention rates include students who started at either school in the middle of the year.

Table 33

Number of Students in Project and in Total at PNGHS

	1995				1996			
	Project		Total		Project		Total	
	Start	End	Start	End	Start	End	Start	End
	N	N	N	N	N	N	N	N
6th formers	54	50	209	180	75	63	238	204
7th formers	105	97	152	121	76	65	153	129

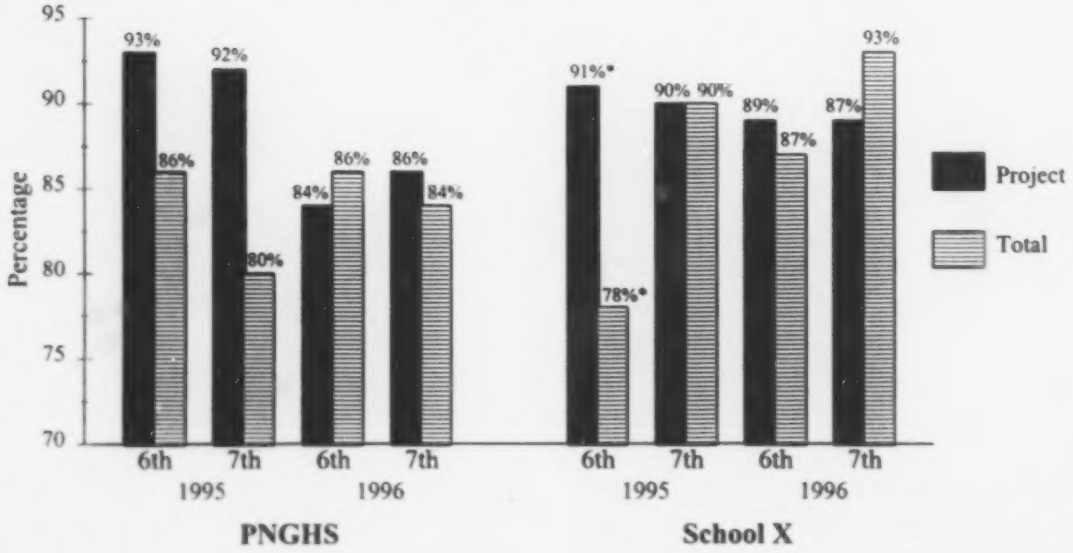
Table 34

Number of Students in Project and in Total at School X

	1995				1996			
	Project		Total		Project		Total	
	Start	End	Start	End	Start	End	Start	End
	N	N	N	N	N	N	N	N
6th formers	32	29	235	184	71	63	245	213
7th formers	125	113	208	187	102	91	194	181

Figure 12

Total School and Project Retention Rates



* Exaggerated due to small numbers.

The 1995 retention rates at PNGHS for students in the project were higher than the PNGHS total rate but not significantly so. There were no differences in the retention rates between or within schools for project classes and the total group in 1995 or 1996. As the retention rate data varied between years and schools, they are difficult to interpret.

Summary of Student Perspectives

Major Changes

Most of the significant changes mentioned in this chapter occurred at PNGHS. For example during 1995 PNGHS students' attitudes towards computers became more positive; during both years students' knowledge of computer terms increased and their use of computers outside school increased; as the project progressed students were more likely to indicate that they knew a moderate amount about computing and agree with positive statements about the use of computers in the classroom.

Some significant changes occurred at School X. For example, 1996 students were more likely to use computers at school in the project subjects than their counterparts in 1995; 1996 students were more likely to use the Internet and educational software at home; and in 1996 students' knowledge of computer terminology increased over the course of the year. There were no significant changes in the use of computers outside school or in students' anxiety towards computing.

Variations Between 1995 and 1996

At PNGHS there appeared to be some differences in the cohort of students starting the project in 1996 compared with those starting in 1995. The 1996 students were more likely to say that they knew a moderate amount about computing, were more likely to have used computers in the 3 project subjects prior to their entry to the project, and were more likely to be using home computers for wordprocessing.

It is difficult to ascertain what these differences were due to: the fact that teachers introduced their junior classes to computers before they entered the project; or a general increase in the use of computers at PNGHS, or in the students' wider community. Essentially, the 1996 cohort appears to have started where the 1995 cohort left off in terms of computer usage and confidence.

Home Variables

Students at School X had more access to home computers in 1995 than students at PNGHS. At the start of 1995 significantly more School X students used computers outside school compared with PNGHS students. By the end of 1995 this difference had disappeared; PNGHS students were using computers outside school more, even though the number of home computers had not increased significantly at either school (it is likely that the requirement at PNGHS that most assignments were to be wordprocessed contributed to some of these changes). This pattern of increasing frequency of use was not evident at School X. At the start of 1996, students at PNGHS used home computers more for wordprocessing compared with their 1995 counterparts.

The majority of students at both schools reported that their parents had positive attitudes towards computers though parents at PNGHS were more likely to encourage students to use computers. Students at School X reported a higher incidence of parental use of computers at work.

Students' Views of the Project

Even given the differences between the 1995 and 1996 cohorts at PNGHS, approximately four-fifths of students in both years indicated that they had acquired a range of skills through participating in the project: mainly increased knowledge of computing over all and spreadsheet and presentation skills. Just over 50 percent indicated that they had transferred the skills they had learnt to other subject areas. Many PNGHS students indicated that they had acquired a range of subsidiary skills such as the ability to work in a group and solve problems as a result of using computers.

Students at PNGHS were divided as to whether the use of computers directly affected their learning of the project subjects, with approximately 50 percent preferring computer assignments and stating that the use of computers made their subjects and lessons more interesting. Most students thought that computers helped them to correct their work.

Students at both schools held similar views on whether it was advantageous or disadvantageous to use computers in the classroom. Approximately 50 percent of students thought it was or would be advantageous, one-third were neutral, and one-sixth thought it was or would be disadvantageous. Compared with students at PNGHS, students at School X were more likely to state that they would like to use a computer at school more often.

PNGHS accounting students saw computers to be more advantageous in their subject area than students of mathematics with statistics. This is likely to reflect to a certain extent the nature of the subjects; accounting involves spreadsheet work that is easily translated on to a computer.

PNGHS students listed approximately the same proportion of advantages and disadvantages of using computers. The major advantages mentioned were the time saved when working on a computer, and the general computing, wordprocessing, and spreadsheeting skills they were acquiring. Disadvantages varied between subjects: for accounting and economics students a major issue was the initial time taken to learn and use computers; for students of mathematics with statistics, the computer doing the calculations was the major disadvantage.

Computer Anxiety

An analysis of the 1995 anxiety data showed that, although most students had a home computer, this did not appear to contribute to reducing anxiety levels unless the computer was used regularly. Positive parental attitudes appear also to be related to lower anxiety levels. The data collected at the start of 1996 appear to support this conclusion: at the start of 1996 students were using home computers more regularly, they reported more familiarity with computers, and they had slightly lower levels of anxiety than their counterparts at the start of 1995.

The implications of the computer anxiety data for the use of computers in the classroom and at home are that computer resourcing needs to be accompanied by a transfer of positive attitudes from teacher or parent to student, and time allocated for students to develop computer skills. Although many students now have computers at home, unless they are receiving instruction on them it is unlikely that they will be using them to their fullest potential.

Attitudes Towards Subjects

PNGHS students on the whole had more positive attitudes towards the subjects they were studying. This could be due to a variety of school or teacher factors, one of which could be the introduction of computers to the classroom. As students at the 2 schools started from different attitudinal positions, it is difficult to interpret any changes.

CHAPTER 4

PERSPECTIVES ON LEARNING

Introduction

This chapter outlines and described the results of the 5 substudies, designed to look at particular facets of the impact of the use of computers on students' learning and skill development, that were conducted in 1996. The background to these studies is described in chapter 1.

Study 1: Information Technology Skills (ITS) Assessment

The aim of Study 1 was to assess whether students' IT skills increased over the 1996 school year by assessing the end-of-course objectives, for all subject areas in the project, that students should display improved keyboard proficiency, and use spreadsheets appropriately to display information. This study also assessed PNGHS research issue (2) that students should display greater confidence in using computers as a tool.

In order to collect appropriate information on these issues, a 3-part assessment was developed. Part A consisted of a practical spreadsheet exercise, with a maximum score of 18, to be completed using spreadsheet software; Part B asked students to complete a 34-item multiple-choice test covering areas such as computer software, hardware, and spreadsheet formulas; and Part C required students to indicate their mastery of 24 IT skills (*see* appendix E for a copy of parts A and C).

Students new to the project in 1996 were given this assessment at the start and end of 1996. Table 35 shows a comparison of students' mean scores at the start and end of 1996 for all parts of the ITS assessment.

Table 35

ITS: Mean Scores

	Start 1996			End 1996			
	N	Mean	s.d.	N	Mean	s.d.	Change
Part A	106	4.95	3.58	71	11.44	5.09	+6.49*
Part B	105	22.51	4.84	71	26.21	3.79	+3.70*
Part C**	106	9.98	4.19	64	18.56	3.07	+8.58*

* Indicates a statistically significant change.

** The Part C mean is the average of the total number of skills students indicated mastery of.

At the end of 1996 Parts A, B, and C of the ITS all showed significant increases compared with the start of 1996.

Students' Self-Assessments

Table 36 shows the percentage of students who indicated that they had each skill listed on Part C of the ITS at the start and the end of 1996.

Table 36

ITS Part C—Self-Evaluation Form

I can:	Start 96 Yes %	End 96 Yes %	Change %
use a keyboard.	98	98	-
use a mouse.	98	100	+2
use the help function on a computer.	53	77	+24*
save information or files on a floppy disk.	77	98	+21*
print files or documents.	84	100	+16*
print multiple copies of a file or document.	67	95	+28*
format a floppy disk.	7	56	+49*
use a spell check to check documents.	66	100	+34*
copy files from one disk to another.	11	63	+52*
use cut and paste.	46	92	+46*
enter data in a spreadsheet.	64	100	+36*
edit data in a spreadsheet.	27	86	+59*
format data in a spreadsheet (e.g., set to 2 decimal places or $).	17	70	+53*
develop formulas in a spreadsheet (e.g., means or percentages).	7	70	+63*
sort data in a spreadsheet.	9	55	+46*
develop graphs from data in a spreadsheet.	16	91	+75*
create documents using a wordprocessor.	67	94	+27*
edit documents using a wordprocessor (e.g., ClarisWorks).	60	94	+34*
format documents using a wordprocessor (e.g., changing fonts).	72	94	+22*
import graphs or graphics into wordprocessed documents.	13	70	+57*
use databases to look up information (e.g., PCInfos, MACGlobe).	41	81	+40*
access files stored in a central directory (e.g., shared file).	21	44	+23*
use the Internet/schools network/World Wide Web.	9	33	+24*

* Indicates a statistically significant change.

Apart from using a keyboard and a mouse (skills that nearly 100 percent of students had at the start of 1996), a significantly greater proportion of students reported mastery of the other skills listed at the end of 1996.

Summary of Study 1

At the end of 1996, skills listed in Parts A, B, and C of the ITS all showed significant increases from the start of 1996. Students showed an increased understanding of IT concepts, and increased proficiency of general IT skills, in particular the use of spreadsheets. All students who completed the assessment had mastered the end-of-course objective, that is, they were able to use a spreadsheet to display information. The majority of students had mastered more complex skills such as developing formulas in spreadsheets, and importing graphics into wordprocessed documents. There were only 2 skills which less than 50 percent of students indicated that they had mastered: using the Internet (this was not part of the project) and accessing files stored in the shared file (some teachers did not use the shared file and therefore not all students were taught this skill).

Similar trends for Part B are shown in 2 studies which used assessments related to Part B. The IEA study (Pelgrum *et al.*, 1993), from which Part B was amended, reported that students using computers both in and outside school gained higher scores on the Functional Information Technology Test compared with students who did not use computers. The ImpacT Report (Watson, 1993), which used an amended version of the IEA test, showed gains over the course of a year for high users of technology in the 14–16 age range compared with low users. Results for students in the 12–14 age range showed no significant changes.

From the data shown here it appears clear that both students' practical IT skills, and understanding of the workings of the technology they were using, were enhanced over the course of the 1996 teaching year, and therefore that the PNGHS research issue (2)—that students should display greater confidence in using computers as a tool—was supported.

Study 2: Co-operative Exercises in 6th Form Accounting

The purpose of Study 2 was to assess the possible impact of the use of computers on students' group work and social skills. This study also helps to assess the PNGHS research issue (5) that the speed of computers should enable students to spend more time devising alternative solutions, etc., and the accounting end-of-course objective (c) that students should be able to use a spreadsheet to produce accounting information. This study also looked at an area additional to the PNGHS research issues, that of the interaction between the use of computers, collaborative learning, and the development of social skills.

This exercise involved the two 6th form accounting classes at PNGHS, that is, 32 students. Groups of students completed 2 co-operative tasks developed by the accounting teachers at PNGHS. Both tasks required the group of students to produce a balance sheet, and took approximately 30 minutes each. Students were divided into groups of 4 or 5. Each group completed one task using spreadsheet software and the second task without the aid of a computer. The tasks were counterbalanced, so that half the students completed each task using the spreadsheet software and the other half manually.

After each task students were asked to complete a self-rating form. In addition to this, each group was rated, using the same categories as the self-rating form, by observers whilst each task was being completed (*see* appendix F for a copy of the student and observer rating forms).

A total of 32 ratings was collected for the computer groups and 31 for the non-computer groups (4 of the non-computer ratings were excluded from the analysis due to inaccuracies in their completion).

Students' Comments on the Co-operative Tasks

Students in the computer groups were asked whether they thought that using a computer helped them complete the task. The majority, 69 percent, thought this was the case. When asked how the use of computers had helped, 44 percent stated that using the spreadsheet formulas helped them complete the tasks and 31 percent mentioned that the layout was easier to set up and change using a spreadsheet:

> It was easier to change mistakes, easier to calculate figures, quicker, move figures from one place to another.

> Because we could change information and figures without having to rewrite it all. By moving figures around we could view the new total.

Nineteen percent commented that they could complete the tasks faster using a computer for example:

> Did calculations for you. Faster to type than write.

Fifty percent of students in the computer groups thought that using a computer helped them work in a group and 50 percent did not. When asked how the use of computers had helped them, students stated that using a computer gave everyone a role, made it easier to share ideas and view information, helped them to spot and correct errors, and was faster or more fun. The following are examples of students' comments:

> There is something for everyone to do, e.g., keyboard, mouse, number etc.

> In some ways as everyone could see the work and discuss the results.

> Everyone could see what was being inputted and mistakes were easily observed then solved together.

Completion of Tasks

All groups except one of the non-computer groups completed the second task accurately. Data were not collected on the first task.

Student Ratings

Students were asked to rate their behaviour whilst completing the group tasks on a 1–5 rating scale (1 = very often, 2 = often, 3 = sometimes, 4 = seldom, 5 = never) on a series of statements that measured their participation in the group, and their use of 4 essential skills:

- problem-solving skills,
- social and co-operative skills,
- communication skills, and
- information skills.

Table 37 shows students' mean self-ratings on the skills (note: a lower mean equates with a higher rating).

Table 37

Self-Ratings on Essential Skills

	Computer groups N = 32 Mean	Non-computer groups N = 27 Mean
Problem-solving and planning skills	9.06	9.78
Social and co-operative skills	5.06	4.04*
Communication skills	3.06	2.93
Information skills	8.09*	9.88
Group roles	6.65	6.67
Total	31.94	32.81

* Indicates that the difference between groups is statistically significant.

Students in the computer groups were more likely to rate themselves highly on information skills (for example, organising and analysing information available, presenting information in a clear and logical manner). Students in the non-computer groups were more likely to rate themselves highly on social and co-operative skills (for example, working co-operatively in a group, contributing to activities in the group). Students in the computer groups rated themselves more highly over all though this difference was not significant.

Students were asked how many roles they had during the course of the tasks. Students in the computer groups reported having more roles on average than the non-computer groups (4.84 and 4.35 respectively), though this difference was not significant. Table 38 shows the percentage of students who participated in each role at some stage during the course of a task.

Table 38

Student Roles

	Computer groups N = 32 %	Non-computer groups N = 27 %
Thinker	100	96
Information organiser	88	85
Encourager	81	63
Negotiator	77	74
Recorder/keyboard operator	63	44
Group leader/spokesperson	58	48
Timekeeper	26	19

The most common role for students in all groups was that of "thinker". Students in the computer groups reported that they acted as an encourager or recorder almost 20 percent more often than students in the non-computer groups, though these differences were not significant.

Observer Ratings

At least one observer watched each group as they performed each task. Observers completed the same rating sheets as students. Table 39 shows observers' mean ratings on the essential skills (note that a lower mean equates with a higher rating).

Table 39

Observer Ratings on Essential Skills

	Computer groups N = 10 Mean	Non-computer groups N = 9 Mean
Problem-solving and planning skills	12.00	11.67
Social and co-operative skills	4.90	6.00
Communication skills	2.90	3.22
Information skills	8.00*	10.67
Group roles	6.00*	8.11
Total	33.80*	39.67

* Indicates that the difference between groups is statistically significant.

As with the students, observers were also likely to rate information skills more highly in the computer groups. Observers also rated the computer groups more highly on group roles and in total.

Comparisons of Ratings

In general, students tended to rate themselves similarly on both tasks (first task mean = 32.34, second task mean = 32.68). The second class that completed each task rated themselves significantly higher than the first (first class mean = 35.20, second class mean = 29.48). This difference is likely to be due to differences in the cultures of the 2 classes.

In order to provide an indication of the validity of the rating scales, the mean ratings of students and observers were compared. Students were significantly more likely to rate themselves highly in total, on problem-solving skills, and on social skills. These differences depended on which group students were in at the time. The differences in ratings of problem-solving skills occurred mostly in the computer groups, and differences in overall and social-skills ratings in the non-computer groups.

Summary of Study 2

The use of computers appears to have made a significant impact on students' information skills for the 2 co-operative tasks reported on here. There was unanimous agreement on this between students and observers, and this conclusion is also supported by the general comments of students. This is perhaps not a surprising result, considering the presentation and ordering options available using spreadsheet software in comparison to working by hand.

Information on the other essential skills was mixed, with observers more inclined to note differences than students. Observers rated the essential skills of students in computer groups at a higher level than students in non-computer groups.

This finding is supported by Lai (1992) who notes that the use of computers often encourages students to work collaboratively and therefore develop skills in this area. The authors of the ImpacT and Plait Reports also commented positively on the development of students' collaborative skills as a result of using computers (Watson, 1993; Gardner *et al.*, 1992).

There is some evidence to suggest that the PNGHS research issue (5), that the speed of computers should enable students to spend more time devising alternative solutions, was supported in this exercise, given that the majority of students thought that the use of spreadsheets helped them complete the tasks, and that for task 2, the only group that did not complete the task was not using a computer. The accounting end-of-course objective (c), that students were able to use a spreadsheet to produce accounting information, was supported by this exercise, as all groups produced a spreadsheet as required for both tasks.

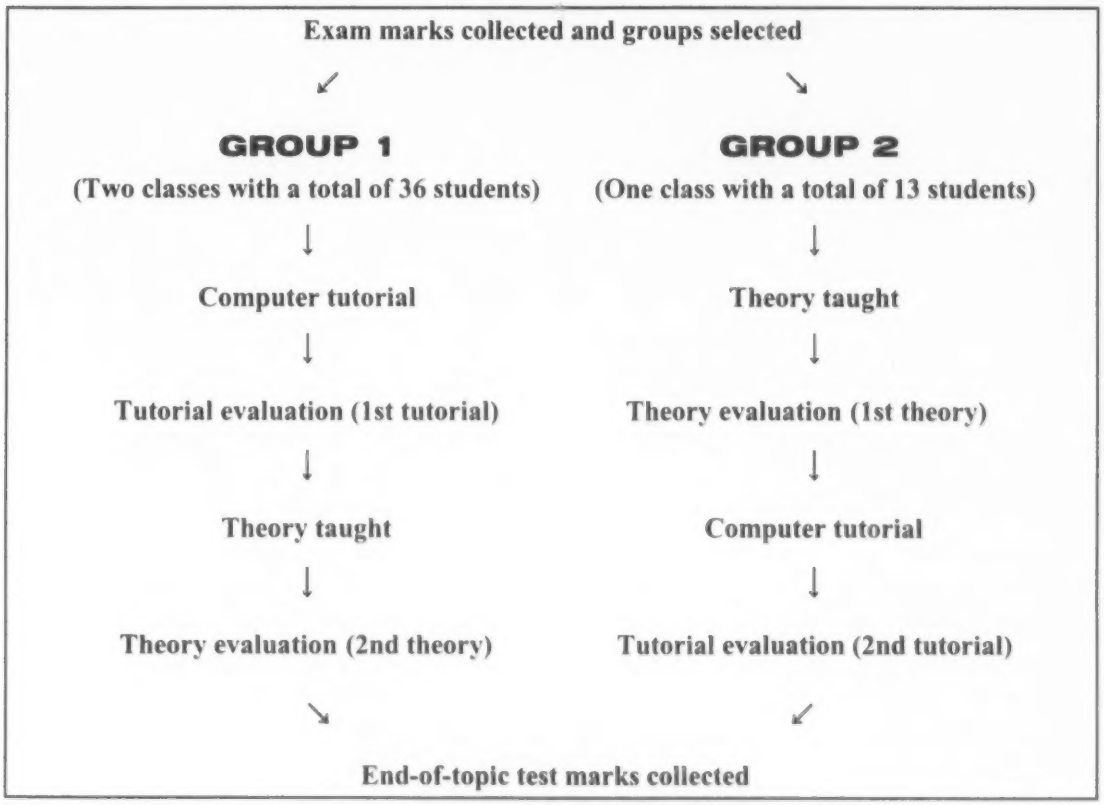
Study 3: Computer Tutorial in Mathematics With Statistics

The purpose of Study 3 was to assess whether a computer tutorial on the subject of Confidence Intervals (CI) increased students' level of understanding of CI. This tutorial included a visual representation of the distribution of 50 sample means compared with one theoretical sample. This exercise was developed from the PNGHS end-of-course objective (b) for mathematics with statistics, that students would be able to understand a computer demonstration of concepts such as the Central Limit Theorem.

Three 7th form classes in mathematics with statistics at PNGHS, that is, 49 students, were divided into 2 groups of similar ability on the basis of performance on the first set of internal

examinations in mathematics with statistics. Students in each group completed 2 evaluation forms, one after completing a tutorial on CI, and the other after a set of theory lessons on CI. The order of presentation of the tutorial and the theory differed between the 2 groups. Students' marks on the end-of-topic CI test were also collected to provide a final measure of their understanding of the topic (*see* table 44). A copy of the tutorial and lesson-rating forms are contained in appendix G. The general design of the exercise is shown by figure 13:

Figure 13 *Design of Study 3*



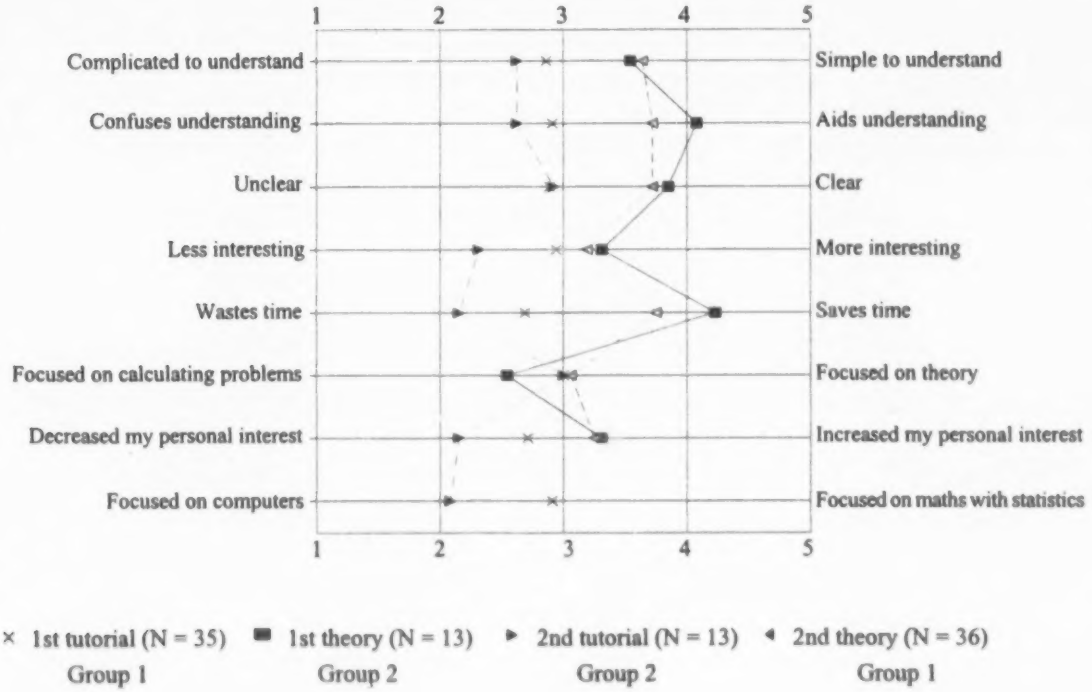
The evaluation forms asked students to rate either the tutorial or the theory lessons on a series of descriptive statements. Other general questions about students' understanding of CI were also asked. The evaluation forms were identical, except that the tutorial forms contained an extra question.

Student Self-Ratings

Students were asked to rate the computer tutorial and the theory lessons, on a range of statements, using a 5-point scale. Figure 14 shows students' mean ratings on each statement by group.

Figure 14

Mean Ratings of Tutorial and Theory Lessons



Students consistently rated the theory lessons significantly higher, and as contributing more to their understanding of the concept of CI, than the computer tutorials.

Understanding of Confidence Intervals

Students were asked to indicate how clear they thought their understanding of CI was as shown by table 40.

Table 40

How Clear Is Your Understanding of Confidence Intervals Now?

	1st tutorial* Group 1 N = 35 %	1st theory Group 2 N = 13 %	2nd tutorial Group 2 N = 13 %	2nd theory Group 1 N = 36 %
Very clear	-	-	-	-
Clear	6	85	62	67
Neither clear nor unclear	51	15	15	22
Unclear	29	-	15	8
Very unclear	4	-	-	3

* The first tutorial group was significantly different from all other groups.

Students in the first tutorial group indicated that their understanding of CI was less clear than the other groups. Once students had received both the tutorial and theory lessons they reported a similar level of understanding.

Tests of Understanding

To provide a measure of the level of students' understanding of CI, students were asked 2 test questions on each evaluation form. These questions were marked by teachers using a 4-point scale ranging from 0 (no understanding or example) to 3 (full understanding or complete example). Mean results for each condition are displayed in tables 41 and 42.

Table 41

What Do You Understand a 95 Percent Confidence Interval To Be?

1st tutorial	1st theory	2nd tutorial	2nd theory
Group 1	Group 2	Group 2	Group 1
N = 35	N = 13	N = 13	N = 36
Mean	Mean	Mean	Mean
0.57	1.15	1.08	1.81

Students in the tutorial groups were less likely to give an adequate or correct explanation of a 95 percent CI. This was especially the case for those in the first tutorial group.

Table 42

Please Describe a Practical Example of a Confidence Interval

1st tutorial	1st theory	2nd tutorial	2nd theory
Group 1	Group 2	Group 2	Group 1
N = 35	N = 13	N = 13	N = 36
Mean	Mean	Mean	Mean
0.37	1.54	1.15	0.61

Students in the first tutorial group were less likely to be able to give a practical example of a CI than students in the second tutorial group. Students in the first theory group were more likely to be able to give a practical example of a CI than students in the second.

Students' Comments on Additional Instruction

On 51 percent of the evaluation sheets students made comments about whether they needed any additional instruction. Students' comments were grouped into the categories in table 43.

Table 43

Is There Any Form of Additional Instruction That Could Help Increase Your Understanding of CI?

	1st tutorial Group 1 N = 35 %	1st theory Group 2 N = 13 %	2nd tutorial Group 2 N = 13 %	2nd theory Group 1 N = 36 %
More theory, notes, explanation, or definitions	31	8	8	11
More practical exercises	6	8	8	25
More formal teaching	23	-	-	-
Integrate computer tutorial with theory	14	-	23	-
Less computer work	3	-	15	-
More time on topic	-	-	-	6
More computer work	3	8	-	-
Miscellaneous	11	-	-	6

Responses varied between groups, with students in the first tutorial group being the most inclined to comment. These students indicated that they would like more theory and formal teaching for example:

> Formal notes from teacher, text notes etc.
>
> Written definitions with illustrated examples.

Students in both tutorial groups commented that more integration between the theory and the computer tutorial would have been beneficial.

> Maybe a statement that goes with the graphs pointing out what is being shown.
>
> More explanation as we are doing the tasks of what we are actually doing so it joins the theory so we will actually learn.

Students in the theory groups tended to comment that they would have liked more practical examples. For example, one student wrote:

> Doing more exercises instead of so many notes.

Students in all groups indicated that they would have liked more theory and practical work (this appears to be a comment on time pressures in general for this topic). Other students provided general comments such as:

> The best and easiest way to understand these is to view the examples on StatView Student because it makes the concept easier to visualise.

School Measures

In addition to data collected from students on the evaluation sheets, some school data were collected for comparative purposes. Table 44 shows students' mean results in the first-term examination and the CI end-of-topic test.

Table 44

Examination and CI End-of-Topic Test Means

	Group 1 Mean	Group 2 Mean
Maths with statistics first-term exam marks	49.54 (N = 37)	47.79 (N = 14)
CI end-of-topic test	15.82 (N = 36)	18.81 (N = 13)

There were no significant differences between groups for either the exam or the end-of-topic test. Group 2, which had started from a lower point than Group 1, reached a higher point on the end-of-topic test. Although these results are not statistically significant, Group 2 appeared to make greater progress.

Summary of Study 3

From the data reported here, it appears that students who completed the tutorial on CI without the background provided by the theory lessons, found the concept of CI more difficult to understand. Once they had participated in the theory lessons, their understanding improved. Students rated the theory lessons as contributing more to their overall understanding of CI compared with the tutorial. They stated that more integration was needed between the tutorial and the theory lessons, as they were having difficulty combining the two.

The information reported here does not appear to support the conclusions of other research and writing on computer simulations and demonstrations (which have some components similar to this tutorial). Asp, Dowsey, and Stacey (1993), Stirling (1992), and Naidu (1994) all view computer simulations as valuable tools that aid students' conceptual understanding and increase students' interest in the topic under consideration. Naidu spent 16 hours introducing and using spreadsheets to demonstrate the Central Limit Theorem and the Law of Long Run Probability to 7th form students in New Zealand. He reported that students found the computer simulation lessons interesting and easy to understand, and concluded that the use of computer simulations made the teaching of these mathematical concepts more interesting and successful. However, the total length of time students spent on this exercise probably influenced these conclusions.

The length of time available for computer demonstrations is also mentioned by Ronen (1995). He noted, when introducing a computer demonstration in physics, that practical difficulties such as a shortage of time and a limited number of computers influenced students more than difficulties with conceptual understanding. He pointed out that new technology was included in the existing teaching system, but this system did not change to include a new allocation of time. He suggested that it is impossible to take advantage of new approaches without adapting the whole area to include this new focus, that is, the curriculum, teaching and learning methods, and examinations.

Stead (1990) commented on the issue of integrating theory with computer demonstrations. He pointed out that successful learning from computer demonstrations cannot be assumed to occur automatically and that most research shows that prior knowledge plays a large role in determining what is learnt. He suggested that students need to receive at least one introductory theory lesson before demonstrations are introduced and that time needs to be spent integrating information from the demonstrations with students' existing knowledge. The comments of students from this study appear to support Stead's statements.

From the reports of students it appears that the PNGHS end-of-course objective (b), that students would be able to understand a computer demonstration of concepts such as the Central Limit Theorem, was met. But it also appears that the use of the computer tutorial did not enhance students' understanding of CI over what they would normally receive. There is a range of possible factors that may have influenced students' viewpoints during this exercise:

- the pressure to complete the Bursary course in a short timeframe, and therefore the amount of time available to study this topic,
- the difficulty of the concepts being studied,
- the way the computer tutorial was designed, and
- the issue of integration of the tutorial and the theory.

All or some of the above may have contributed to the full potential of this tutorial not being realised.

Study 4: Report-Writing Skills in 7th Form Economics

The aim of this study was to assess the possible impact of the use of computer software on the quality of students' internally assessed projects. This study related to the PNGHS research issues (3) that students using computers should be comfortable with various formats of economics information, (5) that the capability of computers should enable students to spend more time practising the skills of analysis, interpretation, decision-making, and evaluating ideas, and (6) that computer-aided learning should assist the development of appropriate report writing.

Students at PNGHS and School X completed the same internally assessed 7th form economics project which required them to investigate the theory of market structures and relate the theory to one New Zealand example. From these students a sample of 10 pairs, matched by 6th Form Certificate grade, was selected from each school (in one case the grade of the School X student was 1 step higher than the matching PNGHS student). The essay part of the internally assessed project was collected from the 20 students selected (students were also required to complete a task definition and a log of the information collected) (*see* appendix H for a copy of the assignment). Of the 20 projects received, all 10 of the PNGHS projects were completed using a wordprocessor and 5 of the School X projects. The other 5 School X projects were completed by hand.

Two independent markers graded the 20 reports on five 5-point scales (*see* appendix H for a copy of the scales). As a control against possible marker effects, the markers were not informed about how the reports were to be compared. The scales were as follows:

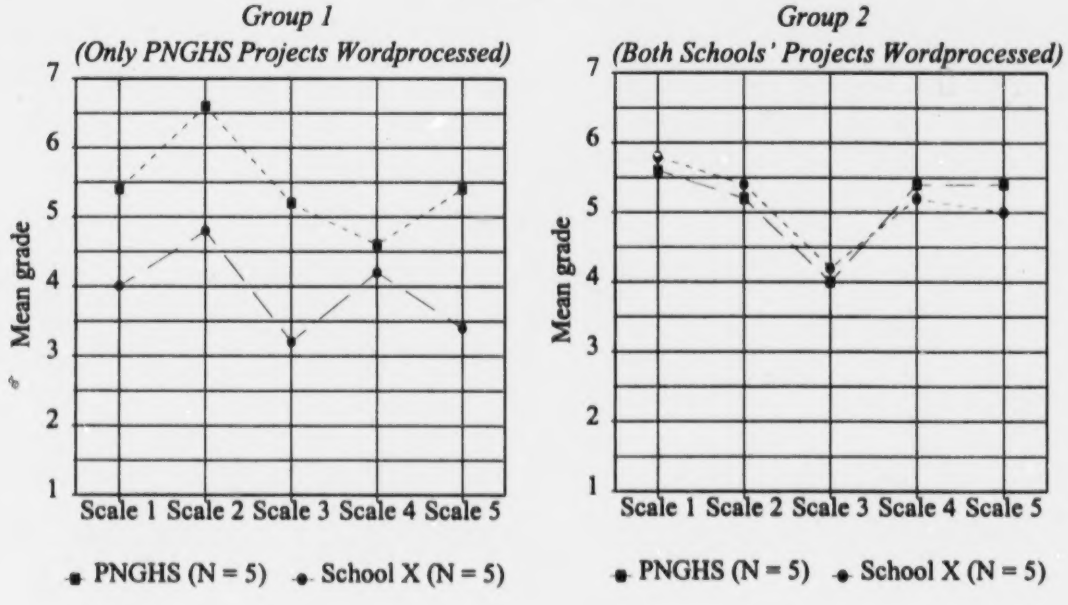
Scale 1: Economic analysis and interpretation of findings.
Scale 2: Use of economic language.
Scale 3: Use of appropriate graphs and tables.
Scale 4: Quality of editing and writing.
Scale 5: Presentation.

Each project was graded from 1 to 5 on each scale. A grade of 1 indicated very low quality, a grade of 3 indicated average quality, and a grade of 5 very high or superior quality. To assess for inter-rater reliability, the 2 markers ranking were compared using Spearman's rho, corrected for tied ranks. The correlation rho = 0.82 was significant beyond the 0.01 level, indicating a high degree of marker reliability. Accordingly the grades of the 2 markers are comparable. Given this, comparisons were completed for 2 groups:

Group 1: the 5 matched pairs for which only PNGHS students' projects were wordprocessed.
Group 2: the 5 matched pairs for which both schools' projects were wordprocessed.

As the numbers in the samples were small, it is difficult to indicate statistically significant effects though strong trends are evident in the data reported here. Over all, markers were more likely to award a grade of 3 or higher to projects from PNGHS in Group 1 but this was not the case for PNGHS projects in Group 2. Figure 15 shows the mean grades for Group 1 (only PNGHS projects wordprocessed) and Group 2 (both schools' projects wordprocessed) on each of the 5 scales.

Figure 15
Mean Grades on Scales



Students who had wordprocessed their projects in Group 1 performed at a higher level on all the scales. The grades awarded to wordprocessed projects on scale 3, use of appropriate tables and graphs, were significantly higher than those awarded to non-wordprocessed projects. When projects from both schools were wordprocessed (Group 2), projects were awarded similar grades.

Table 44 shows the mean grade for the students in each group from 6th Form Certificate, the teachers at PNGHS and School X (when the projects were marked for the purposes of internal assessment), the 2 independent markers, and Bursary.

Table 45

Mean Grade and Marks for Groups 1 and 2

	6th Form Certificate Mean	School* Grading Mean %	Total** Grading Mean	Bursary Score Mean %
Group 1: PNGHS: WP (N = 5)	4.0	48.8	27.2	58.2
Group 1: School X: Non-WP (N = 5)	4.0	42.8	19.6	52.8
Group 2: PNGHS: WP (N = 5)	3.8	49.0	25.6	63.0
Group 2: School X: WP (N = 5)	3.6	50.8	25.6	62.0

* Refers to the grade given to the projects (out of 70 percent) by teachers at PNGHS or School X.

** Refers to the grade on all 5 scales summed for both independent markers.

Given that, at the outset of the exercise, the groups were comparable in terms of ability (as measured by their 6th Form Certificate grade) it appears that, at both schools, there is a trend towards students who wordprocessed projects receiving higher grades that those who did not. This trend is evident whether the projects were marked by the teachers at the 2 schools or by the independent markers. This trend ultimately influenced students' Bursary marks (as the projects were the schools' internal assessment component for Bursary).

Summary of Study 4

The data from this study indicate that wordprocessing has improved the quality of students' projects, and that this was the case for students from both schools. These data support PNGHS research issues (3), (5), and (6), that is, the use of wordprocessing software has aided students in their presentation of graphical or tabular economics information; has allowed students to spend more time practising the skills of analysis and interpretation; and has enhanced students' general report writing and editing skills.

This study supports other research and writing in this area which comments on the benefits of using wordprocessors for writing and in developing positive attitudes towards writing. For example, Hartley (1993) and Van der Klay (1992) reported that the wordprocessing of essays helped less able students. Philips (1995) concluded that the writing of most students had improved over the course of a 2-year case study, though it was difficult to assess whether this was due to the use of wordprocessors or other factors. Students in the Philips study viewed the use of wordprocessors for writing positively.

Study 5: Analysis of Internal and External Marks and Grades

This study was designed to assess the contract objective (b) Is end-of-course academic achievement in the areas under investigation enhanced by an IT-mediated approach? This study also addresses PNGHS research issue (1), that the performance of students with access to computers during the year should be enhanced in the Bursary examination.

School Certificate, 6th Form Certificate, and Bursary results for accounting, economics, mathematics, mathematics with statistics, and English (the control variable) were collected from both schools for students who were in the project for their 7th form year in either 1995 or 1996. To provide a comparison over time the mean Bursary scores, in 1993 and 1994, in the above subjects, were also collected from both schools.

Comparison Between Schools

Tables 46, 47, 48, and 49 show the combined mean grades of project students studying accounting, economics, mathematics, mathematics with statistics, and English. In these tables School Certificate and Bursary are reported as percentages, and 6th Form Certificate as a 1 to 9 grade with 1 being the highest. Only data from the 2 participating schools were collected, therefore if students had changed schools their results were not available. This has contributed to the number of students recorded as sitting School Certificate and 6th Form Certificate being lower than the total number completing Bursary. Some students also started subjects in the 6th form and did not enter School Certificate examinations.

Table 46

Accounting: Mean Grades for 1995 and 1996 7th Formers

	School Certificate			6th Form Certificate			Bursary		
	N	Mean %	s.d.	N	Mean Grade	s.d.	N	Mean %	s.d.
PNGHS	29	72.41*	11.41	36	3.67	1.33	37	58.97	12.37
School X	10	62.60*	11.05	24	3.58	1.47	32	56.88	17.43

* Indicates that the difference between groups is statistically significant.

The School Certificate accounting grades of project students at PNGHS were significantly higher than those of School X. This difference was not evident for 6th Form Certificate or Bursary.

Table 47

Economics: Mean Grades for 1995 and 1996 7th Formers

	School Certificate			6th Form Certificate			Bursary		
	N	Mean %	s.d.	N	Mean Grade	s.d.	N	Mean %	s.d.
PNGHS	37	63.95	6.84	47	3.87	1.33	60	54.28	11.91
School X	25	65.00	8.76	28	3.68	1.42	55	56.60	12.81

There were no significant differences between the economic grades of PNGHS and School X students.

Table 48

Mathematics: Mean Grades for 1995 and 1996 7th Formers

	School Certificate Mathematics			6th Form Certificate Mathematics			Bursary Mathematics with Statistics		
	N	Mean %	s.d.	N	Mean Grade	s.d.	N	Mean %	s.d.
PNGHS	86	74.57*	10.81	100	3.47	1.34	125	54.88	9.93
School X	139	78.54*	10.24	150	3.69	1.58	170	56.14	12.39

* Indicates that the difference between groups is statistically significant.

The School Certificate mathematics grades of project students at PNGHS were significantly lower than those of School X. This difference was not evident for 6th Form Certificate or Bursary.

Table 49

English: Mean Grades for 1995 and 1996 7th Formers

	School Certificate			6th Form Certificate			Bursary		
	N	Mean %	s.d.	N	Mean Grade	s.d.	N	Mean %	s.d.
PNGHS	136	70.42	11.10	133	3.58	1.40	111	55.79	13.09
School X	142	68.13	11.48	165	3.48	1.44	127	57.72	13.30

Data on students' English marks and grades provided an external benchmark for project subjects. There appears to be little variation in the English grades and marks between schools for either School Certificate, 6th Form Certificate, or Bursary. Given this, and as there are no significant differences between schools in any of the 6th Form Certificate or Bursary data, it appears that participation in the project had little effect in either a positive or negative direction on students' Bursary marks. This is hardly surprising considering that for the students at PNGHS the method of examination did not match the method of instruction. In addition there are other factors that could have affected students' grades such as variations in the proportions of students at each school who elected to take each subject.

Comparison Between Years

The data from PNGHS and School X students in the first 2 years of the project were compared to the data from students in the 2 years prior to the project's commencing as shown by tables 50 and 51.

Table 50

PNGHS: Mean Grades for 1993–1996

	Accounting			Economics			Maths with Stats			English*		
	N	Mean %	s.d.	N	Mean %	s.d.	N	Mean %	s.d.	N	Mean %	s.d.
1993	22	53.8	11.3	37	55.1	12.9	68	58.6	12.6	93	59.9	13.5
1994	16	57.9	12.1	20	59.7	11.6	63	56.1	14.3	90	61.2	13.5
1995	21	60.8	10.3	32	54.5	10.5	79	54.9	10.1	65	55.7	13.6
1996	15	57.3	14.9	28	54.1	13.4	48	54.5	9.8	48	55.5	12.4

* For 1995 and 1996 the English mean is calculated only from the project students.

At PNGHS, in 1995, accounting marks were significantly higher than in 1993. In 1995 and 1996 English marks were significantly lower than in 1994.

Table 51

School X: Mean Grades for 1993–1996

	Accounting			Economics			Maths with Stats			English*		
	N	Mean %	s.d.	N	Mean %	s.d.	N	Mean %	s.d.	N	Mean %	s.d.
1993	21	55.3	9.8	32	54.6	15.6	58	57.1	12.9	113	57.1	12.4
1994	20	48.3	11.8	18	55.1	11.3	85	57.3	11.5	110	55.4	12.9
1995	24	55.0	20.3	34	56.6	12.3	92	55.0	9.5	76	56.6	12.7
1996	9	58.0	11.2	21	56.6	14.0	80	56.8	15.2	53	59.1	14.8

* For 1995 and 1996 the English mean is calculated only from the project students.

A comparison of the 1993 and 1994 data with the 1995 and 1996 data showed very few statistically significant variations in mean grades. At School X there were no significant variations. At PNGHS the only variation in a project subject (accounting) was in a positive direction. It is difficult to attribute any cause to these fluctuations, as it is likely that they are due to normal variations between years.

Summary of Study 5

From the data shown above it appears that participation in the project has not enhanced students' performance in the formal setting of the Bursary examination. Another conclusion that could be drawn is that students have not been disadvantaged by using a different method of instruction during the year, compared with that required by the examination system. This second conclusion is perhaps more important given the concerns expressed by some students and teachers about not being able to use computers in Bursary examinations.

Other studies of the effects of using classroom computers on students' achievement have shown mixed results. The authors of the ImpacT Report (Watson, 1993) found both positive and negative differences in students' scores on tests of higher order processes and thinking when the results of a number of classes within schools, divided into 2 groups (users of high and low technology), were compared. When all the data were combined, the overall trend was positive in favour of the users

of high technology but this varied substantially between the 4 subject, and 3 age groupings, in the project.

In his record of the Freyberg study, McKinnon (1995) found that when students in an integrated programme (a programme in which cross-curricula, out-of-class activities were completed with the aid of computers) were compared with those in a traditional programme, students in the integrated programme performed significantly better on School Certificate examinations in English, mathematics, and science. It is unclear whether the reported differences in results were due to existing differences in the 2 groups (as students self-selected to be in either group), the effects on students of the integrated studies approach, the effects of using computers, or other confounding variables.

The Plait Report (Gardner *et al* 1992) compared classes of students who had used laptops for a year with matched control classes of students who had not. Pre- and post-tests of achievement in mathematics, science, and English were given to students at the start and end of the year. There were no significant post-test differences in any of the subject areas.

The above-mentioned studies all used different methods to collect data and different ways to measure students' achievement. Even given this, it appears that it is hard to find conclusive evidence of enhancements to students' learning as a result of using computers when traditional methods of assessment, which do not use computers, and which are focused on the general ability or academic performance of students, are used to evaluate gains. There are many other variables that are not considered in these measurements, which enter into the equation, such as the effects of collaborative learning. The authors of the above studies all reported that the qualitative information they had collected from interviews and observations indicated that enhancement of learning had occurred for students, but the way this occurred varied and was dependent on a variety of factors such as the nature of the tasks students were undertaking and the familiarity of the teachers in question with the IT they were using.

Summary of the 5 Learning Enhancement Studies

From the 5 studies reported here the main effects on students' learning and skill development appear to have been:

- Over the course of a year, students displayed increased practical and conceptual IT skills. All students surveyed were able to complete basic tasks such as displaying data in a spreadsheet, using the spell check, and printing documents. The majority of students had acquired more complex skills such as sorting data in a spreadsheet and importing graphics.
- The use of computers to complete co-operative tasks aided accounting students' development of essential skills especially with regard to information skills such as organising and analysing the information available.
- Although students of mathematics with statistics could complete and understand a computer-based tutorial on confidence intervals, this tutorial did not appear to enhance their understanding of confidence intervals. Students needed more integration between the tutorial and theory to get maximum benefit from the tutorial.
- The use of wordprocessors improved the quality of students' internally assessed 7th form economics projects. This improvement occurred for students at both schools.

- Participation in the project appeared to have no significant positive or negative effects on students' performance in end-of-year Bursary examinations. It does appear, however, that the wordprocessing of internally assessed projects has the potential to enhance students' grades until such time as wordprocessed assignments become the norm.

The above conclusions are tentative and not necessarily generalisable due to the case study nature of this evaluation and the small sample sizes in some of the studies. The conclusions presented here are supported by the information gained at the time of the teacher interviews, for example, information on students' project work, achievement, and the learning of skills (*see* chapter 2, pp. 30–34).

The data reported here indicate that the use of computers in the project, and the classroom environment that this use facilitated, has enhanced students' skills and learning in a variety of ways. As one student said:

> The main advantage of learning on computers is that you learn how to use spreadsheets. Having computers in the classroom helps to make the lessons more understandable and gives you practical skills that could be used outside school.

Though these gains may not be for all students, in all situations in one subject area, or between subjects, it is likely that greater gains would be evident if, as suggested by Ronen (1995), the existing teaching system was adapted more to suit the new technology. In addition, it is also likely that further gains would be shown if more consideration was given to defining the skills students needed to acquire, and the processes by which students integrate information to enable them to develop these skills.

CHAPTER 5

SUMMARY

Summary in Relation to the Contract Research Questions

This summary addresses the contract research questions and PNGHS research issues using the information collected over the course of the evaluation.

Evaluation Question (a)

What impact does an IT-mediated approach have on student and teacher attitudes?

Students

Over the course of the project changes in students' attitudes, mostly in a positive direction, were evident at PNGHS. Changes were shown in data collected from 4 sources: student questionnaires, teacher interviews, teacher diaries, and substudies.

Over the course of 1996, students became more confident in their use of computers and more knowledgeable about IT as a whole. Students who used computers frequently tended to experience positive changes in their attitudes towards computers. In addition students at PNGHS reported:

- increased computer use over the course of the project,
- the transfer of skills they had learnt to other areas (both in and outside school), and
- that the use of computers in their classrooms was, on the whole, advantageous to them.

Teachers reported that by the end of 1995:

- students had come to regard computers as part of the classroom furniture,
- students needed less assistance with hardware and software,
- students' behaviour changed from concentrating on the process of using computers, to focusing on lesson content,
- students were more independent in their selection of work appropriate for computer use,
- changes in classroom dynamics were evident, with students taking on the role of computer "expert" or peer tutor, and
- students were more motivated in lessons where computers were used.

Teachers

Over the course of 1995 mostly positive changes in teachers' attitudes were evident at PNGHS. Changes were shown in data collected from 3 sources, namely, teacher questionnaires, interviews, and diaries. Teachers at PNGHS:

- gained more confidence in using computers and started to experiment with new ideas and with introducing junior classes to the project,

- needed less assistance with hardware and software,
- became more positive about the use of computers for teaching and learning,
- stated that the pattern of interaction facilitated by the use of computers changed the classroom environment to become more student-centred and informal. This change was seen as positive and of benefit to students, and
- changed their views on how to incorporate computers into the classroom, and how to plan computer-based lessons.

Evaluation Question (b)

Is end-of-course academic achievement in the areas under investigation enhanced by an IT-mediated approach?

The data from Study 5 indicated that participation in the project did not appear to influence students' academic performance (as measured by the end-of-year Bursary examinations) in either a significantly positive or negative direction. Although participation in the project did not enhance students' examination performance, nor were students disadvantaged by using a different method of instruction to that required by the examination system. The data from Study 4 indicated that, for students at both schools, the use of computers to complete internally assessed projects was likely to increase the grades awarded to the projects, and therefore Bursary marks.

Evaluation Question (c)

Are students at PNGHS learning via IT achieving at a higher level in relation to the PNGHS research issues and end-of-course objectives? Do achievement levels in these skills change over time?

Issue (1) *The performance of students with access to computers during the year should be enhanced in [the] Bursary examination.*

See Evaluation Research Question (b) above for information on this issue.

Issues (2) and (3) *Students with computers should display greater confidence, on average, in using computers as a tool than those students without.*

Students with computers should be more comfortable with various formats of [subject-based] information.

From information collected in the student questionnaires, teacher interviews, and diaries, and Study 1, the following conclusions may be drawn:

- Over the course of 1995 and 1996 students in the project gained practical spreadsheet and wordprocessing skills, and increased their knowledge of IT concepts and terminology, and they required less assistance with hardware and software.

- Students increased their voluntary use of computers at school and their usage of computers outside school.
- Aside from IT skills, students reported gaining a range of other skills as a result of participating in the project, for example, working with groups.

Issue (4) *Students who are computer adept should be able to translate skills learnt using one computer application program to other similar packages, e.g., ClarisWorks to Microsoft Works, Microsoft Excel to Lotus 1-2-3.*

No direct data on this issue were collected, though students reported that they were transferring skills they had learnt in the project to other subject areas, and when they used computers outside school.

Issues (5) and (6) *The speed and design capabilities of the computer should enable students to spend more time practising the skills of analysis, interpretation, making decisions, devising alternative solutions, evaluating ideas, etc., and so should enable students to develop greater proficiency in these areas as well as greater understanding of them.*

Computer-aided learning should assist the development of appropriate report writing, particularly with respect to structure and logical presentation of ideas. Wordprocessing should assist the edit function of report writing.

From the information collected in the teacher interviews and in Study 4, there is some evidence to suggest that the use of wordprocessors enabled students to concentrate more on the skills listed in Issues (5) and (6).

Teachers observed a range of positive benefits from the use of computer software on students' report-writing abilities. Improved presentation was a major benefit for students and teachers, especially in terms of assignment marking. Teachers indicated that some students' analysis, interpretation, and decision-making skills had been enhanced through the use of computers, though this varied between subjects and between high and low achievers. For some students, such as for those for whom English is a second language, or for those who were poor spellers, teachers observed improvements in report editing.

The data collected for Study 4 showed that, at both schools, students who wordprocessed their internally assessed economics projects tended to display higher order analysis and interpretation skills than those students who completed handwritten projects. Students whose projects were wordprocessed also tended to receive higher presentation and report editing grades.

Evaluation Question (d)

What interaction is there between home environment, particularly in relation to IT, and curricular incorporation of IT at school? What is the impact of school and home interactions?

A home-school interaction was evident in the data collected from the student questionnaires, though it is difficult to ascertain the direction of that interaction. It is likely that a two-way process is being

observed. Although PNGHS students had less access to home computers throughout the project, compared with School X students, their usage of home computers increased to reach a proportion similar to that of School X students. It appears that the use of computers at school had an effect on students' use of home computers. This effect could also be seen in the opposite direction. Students who used computers frequently outside school prior to the start of the project were more likely to feel comfortable about the use of computers. Positive parental attitudes towards computers also appeared to have a positive effect on students' anxiety levels. It is interesting to note that it is the frequency of use of a computer outside school, not the actual ownership of a home computer, that is the factor that varied with students' anxiety levels. This finding suggests that unless students are provided with encouragement and training it is unlikely that they will be getting the maximum benefit from home computers.

Final Summary

The combination of qualitative and quantitative information collected over the course of this evaluation showed a variety of changes over time. In line with overseas research in this area (Gardner *et al.*, 1992; Watson, 1993), the author of this study found changes in students' thinking and learning more clearly discernible from the qualitative information collected. In the present study it was often difficult to find ways reliably to quantify changes, especially given the small sample sizes. Attributing cause to changes observed was also an issue: for example, Is it the use of the software or the collaborative classroom environment that causes a change in students' perceptions, or the interaction of both? Does the use of computers at home influence students' anxiety levels more than the use of computers at school?

From the information presented in this report it is possible to conclude that students' learning and skills were enhanced over the 2-year period that this evaluation occurred (or, at the least, not affected in a negative way), as were the professional skills of teachers involved in the project at PNGHS. Not all changes were constant over time and for every individual, in every subject area. It is likely that more changes or gains from projects of this nature would be evident if the existing teaching system was adapted more to suit new technology, especially with regard to the current examination system, pedagogy, and curriculum resources. In addition, this evaluation reported on the first 2 years of the project; it is likely that further gains would be evident in the long term. Generally, although some concerns were expressed about the details of the way the project was implemented, a number of positive outcomes were evident:

- positive changes in both students' and teachers' attitudes towards the use of computers;
- increased professional development and collegial support for teachers;
- increases in students' knowledge of computing, and practical computing skills, especially with regard to the presentation of information in spreadsheets and wordprocessing assignments—students viewed these skills as extremely useful for their further study and participation in the workforce;
- development of a range of additional skills for students such as the ability to learn independently and work in a group;

- the use of computers aided a change towards student-centred and informal lessons and associated with this was the development of a wider range of roles for teachers and students, for example, students as the computer tutor;
- increases in student motivation in classes where computers were used; and
- increased use of home computers by students.

The primary issues raised by teachers and students were:

Teachers

- *Workload:* The increased workload required of teachers to set up a project of this nature, and the need for more time for ongoing development, was the major issue for teachers.
- *Project planning:* The setting up of a project of this nature, especially the purchase and delivery of hardware and software, and the selection of curriculum-specific software, took longer than planned.
- *Training:* The lack of local curriculum and platform-specific (i.e., MAC-based) training available for teachers.
- *School resourcing and support:* The tendency for the school to invest in hardware and software for students at the expense of staff development was an issue for teachers. Teacher support such as computers outside the classroom for the purposes of planning needed to be part of the initial conceptualisation of the project. Long-term and hidden costs of computer equipment and facilities, such as more powerful OHPs, rooms specially designed for the use of computers, and printing paper, also needed to be budgeted for at the planning phase.
- *Subject-specific issues:* It appears that computers are easier to integrate into the curriculum in some subject areas, for example, accounting, compared with mathematics with statistics. Accounting students used generic spreadsheet and wordprocessing software whereas mathematics students were required to use a range of different software packages and consequently had less time to develop skills using each package.
- *Software support:* The need for advisers to help with the selection of suitable educational software and lesson planning for the integration of computers.

Students

- *Assessment:* Students were concerned that their computer skills would not be assessed in Bursary and were not useful in an examination setting.
- *Keyboard skills:* Some students thought that they needed more basic keyboard training before they entered the project.
- *Software issues:* Students, especially in mathematics with statistics, were concerned about the software doing calculations for them, and felt they were missing out on learning the process.

Although this report describes a case study of the implementation of a computer-based project in one New Zealand school, it is likely that the experiences described in this report have been, are being, and will be, mirrored in many schools around this country and overseas. The issues mentioned above are remarkably similar to those mentioned in various other New Zealand and overseas studies (Chamberlain & Kennedy, 1991; Thomas, 1995; Gilmore, 1993; Hawk, 1996,

Mitchell & Loader, 1993). It appears that resourcing and support for IT initiatives are still concerns for teachers, and that the nature of these concerns has not changed much over the last 6 or 7 years.

Recommendations for Schools and Resource Providers

From the experiences gained from this study it is possible to identify a number of issues that are likely to be general concerns for others setting up similar projects. With this in mind, a number of considerations are suggested for other schools and for providers of curriculum resources and software:

- Introduce professional development in IT for teachers well in advance of introducing computers into the classroom.
- Incorporate computer resources for teachers, and teacher training, as essential parts of the planning process, and as an ongoing element.
- Recognise that staff and students will have a range of levels of competency in and attitudes to, the use of computers, and plan training programmes accordingly.
- Provide support for teachers who wish to purchase a home computer, or provide teachers with laptops, or desktop computers in order that they can incorporate the use of computers into their planning process.
- Develop links with teachers at other schools or educational institutions to share resources.
- Allow plenty of planning time for teachers to incorporate computer use into their lesson plans, and allow flexibility to change plans.
- Consider carefully the layout and design of computer rooms. Room layouts can affect student-teacher interactions. Overheating in computer rooms is a common problem.
- Consider both short-term and long-term equipment purchases, and whether these are to be met by school or department budgets.
- Provide time for teachers to group together to discuss, evaluate, and reflect on the work they are doing.
- Consider the effects of innovation on teachers, and how to develop a culture of innovation in the school.
- Ensure that students develop keyboarding skills at a junior level and that opportunities to practise these skills are provided.
- Ensure that students are taught about the ergonomic use of computers.
- Have clearly set out learning goals for students, and methods of ascertaining attainment of these goals. Goals need to pertain to both computer and subject-based skills.

Recommendations for Policy and Further Research

During the course of this evaluation a number of issues came to the fore as worthy of further research:

- The effect that new technologies are having on teaching methods and classroom environments, especially with regards to changes in classroom dynamics, collaborative learning, and the development of essential skills.

- The effect that new technologies are having on learning methods, for example, the effect of visual demonstrations.
- Further definition of the point at which students become confident computer users, and what is the minimum level of use in a school environment to achieve this? How is this related to the student-to-computer ratio?
- The implication of the use of new technologies for the current examination system and curricula, and for all assessments within the New Zealand Qualifications Framework.

Concerns which could be addressed by the Ministry of Education or educational service providers, when letting contracts for teacher professional development programmes or resource development, are the provision of:

- Curriculum resources which contain suggestions for computer-based exercises.
- Advice to teachers on suitable software for their courses and computer platforms, including how to incorporate the use of this software into lesson plans.

APPENDIX A : PNGHS Student Start and End of 1996 Questionnaires

Palmerston North Girls' High School

Student Questionnaire

First Term 1996

This questionnaire is part of the Evaluation of Learning Enhancement Project commissioned by the Ministry of Education, and undertaken by the New Zealand Council for Educational Research (NZCER).

NZCER is an independent organisation whose purpose is to promote quality education for New Zealanders through research and resources, advice and information.

Your name and responses will be held in **complete confidence**. Individuals will not be identifiable in any report from this study. The information collected in this questionnaire will not be used for school assessments.

The questions that follow ask about your attitudes towards computers, your previous experiences with computers (both at school and outside of school), and your knowledge of computing terms. It is important that we get information about **your** experiences and attitudes only, so please try to answer these questions as accurately as you can. The questionnaire should take about 20 minutes to complete.

INSTRUCTIONS

Please answer this questionnaire by

ticking all boxes that apply

AND/OR *writing in the space provided.*

Section A: Background Information

Code [ ]

1) Please write your name in full: .....

2) Please write your date of birth: ...../...../.....
(Day) (Month) (Year)

3) Which of the following subjects are you studying this year? *(Please tick all boxes that apply.)*

☐ a) 6th form accounting
☐ b) 7th form accounting
☐ c) 6th form economics
☐ d) 7th form economics
☐ e) 6th form computer studies
☐ f) 7th form computer studies
☐ g) 7th form maths with statistics

4) Please indicate how you feel about each subject you are studying by using the scale below. Draw a circle around the number that corresponds to how you feel about each subject.

1 = Very positive about the subject
2 = Positive about the subject
3 = Neither positive nor negative about the subject
4 = Negative about the subject
5 = Very negative about the subject

	Very positive				Very negative	Not studying subject in 1996
a) 6th form accounting	1	2	3	4	5	☐
b) 7th form accounting	1	2	3	4	5	☐
c) 6th form economics	1	2	3	4	5	☐
d) 7th form economics	1	2	3	4	5	☐
e) 7th form maths with statistics	1	2	3	4	5	☐

5) Which of the following subjects (if any) do you think you will continue with either at school, university or polytechnic next year?

☐ a) Accounting ☐ b) Economics ☐ c) Maths with statistics ☐ d) None of these

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Section B: Attitudes to Computers

The next few questions ask about your attitudes towards computers.

6) **Please indicate how you feel about the following statements by using the scale below. Draw a circle around the number that corresponds to how you feel about each statement.**

(CAIN OMITTED DUE TO COPYRIGHT)

7) **What do you think about computers in schools and in the workforce? Please tick one box alongside each statement to show whether you agree, are not sure, or disagree.**

		I agree	I am not sure	I disagree
a)	Everyone should learn to use a computer at school.....	☐	☐	☐
b)	It is more enjoyable to read a book than use a computer.....	☐	☐	☐
c)	Most school homework could be done easily on a computer.....	☐	☐	☐
d)	I would be comfortable with using a computer in the workforce...	☐	☐	☐
e)	I would like to use a computer more often at school.....	☐	☐	☐
f)	Schools should buy more computers.....	☐	☐	☐
g)	Doing school work by yourself on a computer is boring.....	☐	☐	☐
h)	I would like to have a job which uses computers	☐	☐	☐

Section C: Experience With Computers

As well as finding out about your attitudes towards computers we would like to know whether you have used computers inside and outside school.

8) Before this year (1996) have you studied computing or attended a computing course? *(If you answer "yes" to this question please indicate, in the space provided, the amount of time you spent on the course.)*

☐ a) Yes - in 6th form computer studies ☐ b) Yes - in other subject for ..... weeks
☐ c) Yes - outside of school for ..... weeks ☐ d) No

9) Before this year (1996) have you ever used a computer for any of the following at school? *(Please tick all boxes that apply.)*

☐ a) Have not used a computer ☐ b) Maths ☐ c) Accountancy ☐ d) Economics
☐ e) Computer studies ☐ f) Doing homework ☐ g) Playing games ☐ h) Taking tests
☐ i) Other areas

Please describe the other areas you have used computers in:

_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

10) Which of the following best describes how much you know about using computers?

☐ a) Quite a lot ☐ b) A moderate amount ☐ c) Not very much ☐ d) Nothing at all

11) Have you written any computer programmes?

☐ a) Yes ☐ b) No

12) Have you belonged to a computer club, computer user group, or a bulletin board group?

☐ a) Yes ☐ b) No

13) Does your family have a computer at home?

☐ a) Yes ☐ b) No

14) Do either of your parents (or guardians) use computers at work?

☐ a) Yes ☐ b) No ☐ c) Don't know

15) Your mother's (or guardian's) occupation is: 1 2 3 4 5 6 7 8 9

16) Your father's (or guardian's) occupation is: 1 2 3 4 5 6 7 8 9

17) How would you describe your parents' (or guardians') attitude towards computers? *(Please tick all boxes that apply.)*

☐ a) Positive ☐ b) Neutral ☐ c) Negative

18) Do you use a computer outside school? *(Please tick all boxes that apply.)*

☐ a) Yes - at home
☐ b) Yes - at parents'/guardians' work place
☐ c) Yes - at a friend's home
☐ d) Yes - other location
☐ e) No **(Go to question 24, section D, page 6)**

19) How often, on average, do you use a computer outside school?

☐ a) Occasionally ☐ b) 1-3 times a week ☐ c) 4-6 times a week
☐ d) Every day ☐ e) Have access to a computer but do not use it

20) How much time would you spend on average, per week on a computer, outside school?

☐ a) No time ☐ b) Use occasionally ☐ c) Up to 1 hour a week
☐ d) About 2 hours a week ☐ e) About 3 hours a week ☐ f) About 4 hours a week
☐ g) About 5 hours a week ☐ h) About 6 hours a week ☐ i) More than 6 hours a week

21) Do your parents (or the people you live with) encourage you to use a computer?

☐ a) Yes ☐ b) No ☐ c) They neither encourage or discourage me

22) Do you spend time working with your parents (or the people you live with) on a computer?

☐ a) Yes ☐ b) No

23) Do you use a computer, outside of school, for any of the following? *(Please tick all boxes that apply.)*

	Do not use	Use very occasionally	Use up to 1 hr a week	Use 1-2 hrs a week	Use more than 2 hrs a week
	a	b	c	d	e
a) Games	☐	☐	☐	☐	☐
b) Educational programmes	☐	☐	☐	☐	☐
c) Homework	☐	☐	☐	☐	☐
d) Spreadsheets	☐	☐	☐	☐	☐
e) Wordprocessing (writing)	☐	☐	☐	☐	☐
f) Drawing/graphic design	☐	☐	☐	☐	☐
g) Desktop publishing	☐	☐	☐	☐	☐
h) Atlas/encyclopaedia	☐	☐	☐	☐	☐
i) Reading	☐	☐	☐	☐	☐
j) Bulletin boards/Internet	☐	☐	☐	☐	☐
k) Other *(please describe)*	☐	☐	☐	☐	☐
	a	b	c	d	e

.....

Section D: Knowledge of Computing Terms

24) On the left are a number of computer terms. From the descriptions on the right choose the one that best matches each term and write the letter of that description in the box [ ] along side each term.

	TERM		DESCRIPTION
A)	**i File**	[ ]	A) A set of instructions written for the computer.
	ii Computer program	[ ]	B) A brand of microcomputer.
	iii VDU	[ ]	C) A small device used to control the screen pointer.
	iv Floppy disk	[ ]	D) A TV-like screen for displaying information.
	v Mouse	[ ]	E) A stored collection of information.
			F) Access to information from a terminal.
			G) A magnetic device for storing information.
B)	**i Network**	[ ]	A) Information entering a computer.
	ii Input	[ ]	B) A part of the computer that stores information.
	iii Memory	[ ]	C) A diagram representing the sequence of steps in a program.
	iv Laptop	[ ]	D) A series of connected computers.
	v Software	[ ]	E) The computer program and instructions.
			F) A portable computer.
			G) The results required by the user.
C)	**i Cursor**	[ ]	A) A list of programs to choose from.
	ii Editing	[ ]	B) A disk that is read by lasers.
	iii Menu	[ ]	C) Information printed onto paper.
	iv CD-ROM	[ ]	D) A symbol on the screen to tell you where the next character you
	v Hardware	[ ]	type will appear.
			E) Making corrections and changes in a program or data.
			F) The physical parts of a computer.
			G) A computer which responds rapidly to the user.
D)	**i Internet**	[ ]	A) Numbers, words, or facts.
	ii Output	[ ]	B) A computer language.
	iii Byte	[ ]	C) An international computer network.
	iv Graphics	[ ]	D) The results required by the user.
	v Data	[ ]	E) Access to information from a computer terminal.
			F) Pictures and diagrams produced on a computer.
			G) A unit of computer storage.

25) Are there any comments you wish to make on the use of computers in the classroom?

1 2 3

4 5 6

7 8 9

Thank you very much for your time in completing this questionnaire.
Please return this questionnaire to your classroom teacher.

Palmerston North Girls' High School

Student Questionnaire

Fourth Term 1996

This questionnaire is part of the Evaluation of the Learning Enhancement Project commissioned by the Ministry of Education, and undertaken by the New Zealand Council for Educational Research (NZCER).

NZCER is an independent organisation whose purpose is to promote quality education for New Zealanders through research and resources, advice and information.

Your responses to this questionnaire will be held in **complete confidence**. Individuals will not be identifiable in any report from this study. The information collected in this questionnaire will not be used for school assessments. On the first page of this questionnaire is a code number. This number is for administrative purposes and enables us to track any changes in your attitudes.

The questions that follow ask about your attitudes towards computers in general and in relation to the subjects you have studied this year. You may remember answering some of these questions at the beginning of the year. We are repeating some questions so that we can get an idea of whether your attitudes have changed over the course of the year.

Some of the questions that follow ask about the **CAL** project. This refers to the **computer-assisted learning** project for the subjects: **accounting**, **economics**, and **mathematics with statistics**.

It is important that we get information about **your** experiences and attitudes only, so please try to answer these questions as accurately as you can. This questionnaire should take about 20 minutes to complete.

INSTRUCTIONS

Please answer this questionnaire

by ticking all boxes that apply

AND/OR *by writing in the space provided.*

Section A: Information on Subject Areas Code [ ]

1) Please indicate how you feel about each subject you are studying by using the scale below. Draw a circle around the number that corresponds to how you feel about each subject.

1 = Very positive about the subject
2 = Positive about the subject
3 = Neither positive nor negative about the subject
4 = Negative about the subject
5 = Very negative about the subject

	Very positive				Very negative	Not studying subject in 1996
a) 6th form accounting	1	2	3	4	5	☐
b) 7th form accounting	1	2	3	4	5	☐
c) 6th form economics	1	2	3	4	5	☐
d) 7th form economics	1	2	3	4	5	☐
e) 7th form maths with statistics	1	2	3	4	5	☐

2) Which of the following subjects (if any) do you think you will continue with either at school, university, or polytechnic next year?

☐ a) Accounting ☐ b) Economics ☐ c) Maths with statistics ☐ d) None of these

3) Do you think you have gained any skills as a result of using computers for accounting, economics or maths with statistics?

☐ a) Yes ☐ b) No ***(Go to question 5)*** ☐ c) Not sure

4a) Which of the following do you think you have gained, or improved, as a result of using computers for ACCOUNTING? *(If you did NOT study accounting this year please go to the next question.)*

☐ a) Knowledge of accounting ☐ b) Wordprocessing skills ☐ c) Spreadsheeting skills
☐ d) Database skills ☐ e) General computer knowledge ☐ f) Group work skills
☐ g) Social skills ☐ h) Problem solving skills ☐ i) Ability to teach yourself
☐ j) Other *(please describe)*

_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

4b) Which of the following do you think you have gained, or improved, as a result of using computers for ECONOMICS? *(If you did NOT study economics this year please go to the next question.)*

☐ a) Knowledge of economics ☐ b) Wordprocessing skills ☐ c) Spreadsheeting skills
☐ d) Database skills ☐ e) General computer knowledge ☐ f) Group work skills
☐ g) Social skills ☐ h) Problem solving skills ☐ i) Ability to teach yourself
☐ j) Other *(please describe)*

_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

4c) Which of the following do you think you have gained, or improved, as a result of using computers for MATHS WITH STATISTICS? *(If you did NOT study maths with statistics this year please go to the next question.)*

☐ a) Knowledge of maths with stats.
☐ b) Wordprocessing skills
☐ c) Spreadsheeting skills
☐ d) Database skills
☐ e) General computer knowledge
☐ f) Group work skills
☐ g) Social skills
☐ h) Problem solving skills
☐ i) Ability to teach yourself
☐ j) Other *(please describe)*

1 2 3
4 5 6
7 8 9

_____

_____

_____

5) Have you used a computer at school this year for any non-CAL subjects? *(That is subjects OTHER than accounting, economics, or maths with statistics.)*

☐ a) Yes ☐ b) No

6) Have you used skills learnt in CAL subjects in other subject areas (e.g., wordprocessing assignments, using databases)?

☐ a) Yes ☐ b) No ☐ c) Not sure

d) If yes, please describe the skills you have used in other subject areas:

d 1 2 3
4 5 6
7 8 9

_____

_____

_____

7) For each of the subjects below do you think there are more ADVANTAGES or DISADVANTAGES in learning with computers? Draw a circle around the number that corresponds to your views for each subject.

1 = A lot more advantages
2 = More advantages
3 = Neither more advantages nor disadvantages
4 = More disadvantages
5 = A lot more disadvantages

	A lot more advantages				**A lot more disadvantages**	**Not studying subject in 1996**
a) 6th form accounting	1	2	3	4	5	☐
b) 7th form accounting	1	2	3	4	5	☐
c) 6th form economics	1	2	3	4	5	☐
d) 7th form economics	1	2	3	4	5	☐
e) 7th form maths with statistics	1	2	3	4	5	☐

f) Please describe the main ADVANTAGES (if any) of learning with computers:

f 1 2 3
4 5 6
7 8 9

_____

_____

_____

g) Please describe the main DISADVANTAGES (if any) of learning with computers:

g 1 2 3
4 5 6
7 8 9

_____

_____

Section B: Attitudes to Computers

The next few questions ask about your attitudes towards computers.

8) Please indicate how you feel about the following statements by using the scale below. Draw a circle around the number that corresponds to how you feel about each statement.

(CAIN OMITTED DUE TO COPYRIGHT)

9) What do you think about computers in schools and in the workforce? Please tick one box alongside each statement to show whether you agree, are not sure, or disagree.

		I agree	I am not sure	I disagree
a)	Everyone should learn to use a computer at school.....	☐	☐	☐
b)	It is more enjoyable to read a book than use a computer.....	☐	☐	☐
c)	Most school homework could be done easily on a computer.....	☐	☐	☐
d)	I would be comfortable with using a computer in the workforce...	☐	☐	☐
e)	I would like to use a computer more often at school.....	☐	☐	☐
f)	Schools should buy more computers.....	☐	☐	☐
g)	Doing school work by yourself on a computer is boring.....	☐	☐	☐
h)	I would like to have a job which uses computers	☐	☐	☐

Section C: Experience With Computers

10) What do you think about computers and learning in your classroom? Please tick one box alongside each statement to show whether you agree, are not sure, or disagree.

	I agree	I am not sure	I disagree
a) I learn a lot on the computer	☐	☐	☐
b) Computers make my subjects more interesting	☐	☐	☐
c) I need a lot of help when I am working on the computer	☐	☐	☐
d) The computer helps me correct my work	☐	☐	☐
e) I have to hurry when I work on the computer	☐	☐	☐
f) I like computer work better than written assignments	☐	☐	☐
g) Computers help me to write better	☐	☐	☐
h) Computers help me to understand the subjects I am doing	☐	☐	☐
i) I can do most work on the computer without any help	☐	☐	☐
j) Computers make lessons more interesting	☐	☐	☐

11) Which of the following best describes how much you know about using computers?

☐ a) Quite a lot ☐ b) A moderate amount ☐ c) Not very much ☐ d) Nothing at all

12) Does your family have a computer at home?

☐ a) Yes ☐ b) No

13) Do you use a computer outside of school? *(Please tick all boxes that apply.)*

☐ a) Yes - at home
☐ b) Yes - at parents'/guardians' work place
☐ c) Yes - at a friend's home
☐ d) Yes - other location
☐ e) No ***(Go to question 16)***

14) How often, on average, do you use a computer outside of school?

☐ a) Occasionally ☐ b) 1-3 times a week ☐ c) 4-6 times a week
☐ d) Every day ☐ e) Have access to a computer but do not use it

15) How much time would you spend on average, outside of school, per week on a computer?

☐ a) No time ☐ b) Use occasionally ☐ c) Up to 1 hour a week
☐ d) About 2 hours a week ☐ e) About 3 hours a week ☐ f) About 4 hours a week
☐ g) About 5 hours a week ☐ h) About 6 hours a week ☐ i) More than 6 hours a week

Section D: Knowledge of Computing Terms

16) On the left are a number of computer terms. From the descriptions on the right choose the one that best matches each term and write the letter of that description in the box [ ] along side each term.

	TERM		DESCRIPTION
a)	**i File** [ ]	A)	A set of instructions written for the computer.
	ii Computer program [ ]	B)	A brand of microcomputer.
	iii VDU [ ]	C)	A small device used to control the screen pointer.
	iv Floppy disk [ ]	D)	A TV-like screen for displaying information.
	v Mouse [ ]	E)	A stored collection of information.
		F)	Access to information from a terminal.
		G)	A magnetic device for storing information.
b)	**i Network** [ ]	A)	Information entering a computer.
	ii Input [ ]	B)	A part of the computer that stores information.
	iii Memory [ ]	C)	A diagram representing the sequence of steps in a program.
	iv Laptop [ ]	D)	A series of connected computers.
	v Software [ ]	E)	The computer program and instructions.
		F)	A portable computer.
		G)	The results required by the user.
c)	**i Cursor** [ ]	A)	A list of programs to choose from.
	ii Editing [ ]	B)	A disk that is read by lasers.
	iii Menu [ ]	C)	Information printed onto paper.
	iv CD-ROM [ ]	D)	A symbol on the screen to tell you where the next character you type will appear.
	v Hardware [ ]	E)	Making corrections and changes in a program or data.
		F)	The physical parts of a computer.
		G)	A computer which responds rapidly to the user.
d)	**i Internet** [ ]	A)	Numbers, words, or facts.
	ii Output [ ]	B)	A computer language.
	iii Byte [ ]	C)	An international computer network.
	iv Graphics [ ]	D)	The results required by the user.
	v Data [ ]	E)	Access to information from a computer terminal.
		F)	Pictures and diagrams produced on a computer.
		G)	A unit of computer storage.

17) Are there any final comments you wish to make on the use of computers in the classroom?

1 2 3

4 5 6

7 8 9

Thank you very much for your time in completing this questionnaire.
Please return this questionnaire to your classroom teacher.

APPENDIX B : PNGHS Teacher Start of 1995 Questionnaire

Teacher Questionnaire

Palmerston North Girls' High

This questionnaire is part of the Evaluation of Learning Enhancement Project commissioned by the Ministry of Education, and undertaken by the New Zealand Council for Educational Research (NZCER).

NZCER is an independent organisation whose purpose is to promote quality education for New Zealanders through research and resources, advice and information.

Your name and responses will be held in **complete confidence**. Individuals will not be identifiable in any report from this study.

Instructions

Please answer this questionnaire

by ticking all boxes that apply

AND/OR *by writing in the space provided.*

Code [ ]

SECTION A - BACKGROUND INFORMATION

1) **Please write your name:** .....

2) **Please indicate how many years you have been teaching:** .....**Years**

3) **Please indicate your current position:** .....

4) **Which of the following subjects will you teach in 1995?**

☐ a) 6th form accounting ☐ b) 7th form accounting
☐ c) 6th form economics ☐ d) 7th form economics
☐ e) 7th form maths with statistics

SECTION B - COMPUTER EXPERIENCE AND USAGE

5) **Before 1995 did you ever use a computer as a teaching aid?**

☐ a) Yes for ..... years ☐ b) No

6) **If you have used a computer as a teaching aid, what did you used it for?**

1 2 3
4 5 6
7 8 9

7) **How would you describe your understanding of computing?**

☐ a) Excellent ☐ b) Very good ☐ c) Average ☐ d) Basic ☐ e) No understanding

8) **Have you belonged to a computer club, computer user group, or a bulletin board group?**

☐ a) Yes ☐ b) No

9) **Have you any computing qualifications?**

☐ a) Yes **(please describe)** ☐ b) No

c 1 2 3
4 5 6
7 8 9

10) Prior to the commencement of the learning enhancement with information technology project had you attended any inservice training/courses/seminars on computers?

☐ a) Yes **(please describe)** ☐ b) No

_____

_____

_____

_____ c 1 2 3

_____ 4 5 6

_____ 7 8 9

11) Do you have your own home computer?

☐ a) Yes ☐ b) No

SECTION C - THE INTRODUCTION OF COMPUTERS IN THE CLASSROOM

12) Please rank from 1 (most important) to 5 (least important) the factors you considered when selecting software packages for your course:

Factor	**Rank**
a) Cost	.....
b) Availability	.....
c) Suitability to curriculum	.....
d) Compatibility with hardware	.....
e) Other **(please describe)**	
f) Did not select software	☐

13) Approximately how much time have you spend familiarising yourself with the hardware and software you will be using in the classroom?

..... hours

14) How did you spent this time?

_____ 1 2 3

_____ 4 5 6

_____ 7 8 9

15) Have you done any formal training on the software you will be using in the classroom?

☐ a) Yes ☐ b) No

16) Do you feel comfortable about your level of skill in using the software/hardware?

☐ a) Very comfortable ☐ b) Comfortable ☐ c) Okay ☐ d) A bit uneasy

17) Do you feel that the software fitted easily into your curriculum objectives/classroom practice?

☐ a) Yes ☐ b) No

18) Are there any resource people or resources that you have been using when you need information about software packages, installation, and any computing problems you might have?

☐ a) Other teachers at your school
☐ b) Other teachers at another school
☐ c) People in industry
☐ d) University or Teachers College contacts
☐ e) Ministry of Education contacts
☐ f) Teacher Support Services contacts
☐ g) Friends/relatives
☐ h) Other contacts (please describe)

_____ i 1 2 3
_____ 4 5 6
_____ 7 8 9

19) When did you develop these support systems and contacts?

☐ a) Recently ☐ b) Previously (old contacts) ☐ c) Do not have support systems

20) Have you had any technical problems with the installation and running of the computer system?

☐ a) Installation problems
☐ b) Running problems
☐ c) Space/storage problems
☐ d) Other problems

(Please describe any problems:)

_____
_____
_____
_____ e 1 2 3
_____ 4 5 6
_____ 7 8 9

21) Did you solve the problems yourself or did you get help?

☐ a) Solved by self ☐ b) Got help ☐ c) No problems experienced

Please describe where you got help from:

_____
_____
_____
_____ d 1 2 3
_____ 4 5 6
_____ 7 8 9

22) Do you feel the support systems for the introduction of computers into your classroom are adequate?

☐ a) Yes ☐ b) No

23) Is there any computer support/professional development you feel you would benefit from?

Please describe:

_____

_____

_____

_____ 1 2 3

_____ 4 5 6

_____ 7 8 9

_____

SECTION D - ATTITUDES TO COMPUTERS IN THE CLASSROOM

24) Please indicate how you feel about the following statements by using the scale below. Draw a circle around the number that corresponds to how you feel about each statement.

1 = Strongly agree
2 = Agree
3 = Neutral
4 = Slightly disagree
5 = Strongly disagree

	Strongly agree				Strongly disagree
a) Computers are valuable tools to improve the quality of a student's education	1	2	3	4	5
b) Working with computers in class distorts the social climate	1	2	3	4	5
c) Using computers in class leads to more productivity in students	1	2	3	4	5
d) Students are more attentive when computers are used in class	1	2	3	4	5
e) I can well do without the aid of a computer in my class	1	2	3	4	5
f) Computers help to teach more effectively	1	2	3	4	5
g) My way of teaching is positively affected when using a computer for teaching	1	2	3	4	5
h) Computers enhance students' creativity	1	2	3	4	5
i) The achievement of students can be increased when using computers for teaching	1	2	3	4	5
j) A computer is not suited for teaching purposes	1	2	3	4	5
k) Children should begin to use a computer at an early age	1	2	3	4	5
l) Using a computer in a classroom makes a subject more interesting	1	2	3	4	5
m) Computers can only be useful in a few subjects	1	2	3	4	5
n) The more use I make of computers in class, the less time I would have to concentrate on the curriculum	1	2	3	4	5
o) Students should be kept away from computers	1	2	3	4	5

25) Are there any comments you wish to make on the use of computers in the classroom?

_____

_____

_____

_____ 1 2 3

_____ 4 5 6

_____ 7 8 9

_____

Thank you for your time in completing this questionnaire.
Could you please return it, in the envelope provided, to NZCER, PO Box 3237, Wellington.

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APPENDIX C : PNGHS October Teacher Interview

Palmerston North Girls' High
Third Teacher Interview: October 1995 Code [ ]

Anything you say in this interview will be treated confidentially. There is no obligation to answer any questions you are not comfortable with. With your consent I would like to tape the interview. The tape will only be heard by myself and possibly one other person at NZCER.

The main purpose of this interview is to find out more about the impact of the CAL project on you and your students. When answering these questions I would like you to try and focus, if possible, on any issues and changes that have happened since my visit in the second term (13/14 July).

1) Code: ..... 2) Date of interview: ...../...../..... 3) Time of interview: .....

4) Place of interview:.....

SECTION A - COMPUTERS ISSUES

In the first section of this interview I will be asking general questions about the hardware, software, computer support services, and training available to you.

5) How is the CAL project going for you at this stage?

1 2 3

4 5 6

7 8 9

6) Have you had any recent technical problems with the software or hardware? (networking, printing, crashes, freezing, data show?)

1 2 3

4 5 6

7 8 9

7) Since the second term have you developed any further contacts for information about computers in your subject area? (Who are they? or Where did you get the information from?)

1 2 3

4 5 6

7 8 9

8) **Since the second term have you received any additional training or professional development for the CAL project? Please describe?**

1 2 3

4 5 6

7 8 9

9) **If you have attended training or professional development sessions, did you get what you expected from them?**

1 2 3

4 5 6

7 8 9

10) **Are there any training or skills you would still like to have for the CAL project? (Is this training available? Will you attend?)**

1 2 3

4 5 6

7 8 9

SECTION B - IMPACT ON TEACHERS

I will now move on to some questions on your workload, professional development opportunities and teaching practices.

11) **Currently, is this project having an impact on your personal and/or professional development?**

1 2 3

4 5 6

7 8 9

12) What is the impact of this project on your workload now?

1 2 3

4 5 6

7 8 9

13) How do you feel about your level of computer proficiency and your ability to develop lessons using a computer?

1 2 3

4 5 6

7 8 9

14) Have the ways that you use computers for teaching changed over the course of the year? (HOW?? Amount of time/change in approach?)

1 2 3

4 5 6

7 8 9

15) Have there been any changes to the level of access you have to computers for planning purposes?

1 2 3

4 5 6

7 8 9

16) **Have there been any further changes to the way you do your lesson planning for the CAL project?** Prompt: Are you still working in groups to develop lessons?

1 2 3

4 5 6

7 8 9

17) **Have you noticed any changes to your classroom management style since the second term, which are likely to be due to using computers for instruction?**

1 2 3

4 5 6

7 8 9

18) **Do you think that using computers in your classroom makes any difference to your relationship with students?**

1 2 3

4 5 6

7 8 9

19) **How do you feel about your progress through the syllabus in comparison to previous years? Is this a concern?**

1 2 3

4 5 6

7 8 9

20) Since the second term have you developed any assessments for your subject area using a computer? What type of assessments were these? What were the outcomes?

1 2 3

4 5 6

7 8 9

21) Do you think that using computers made any difference to students' projects compared to previous years? Could you tell me about the projects your students completed? Prompt: Marking range? More use of analytical skills? How much WP/SS required?

1 2 3

4 5 6

7 8 9

SECTION C - IMPACT ON STUDENTS

I will now ask about your views on the impact of the project on students.

22a) How do you think students are currently finding the computer-based lessons? Has students' attitude or motivation towards CAL lessons changed since the second term (more/less positive)?

1 2 3

4 5 6

7 8 9

b) Does students' attitude or motivation differ between the students in a class or between classes?

1 2 3

4 5 6

7 8 9

23) Have students expressed any concerns about bursary and computer work for example: that they cannot take computers into exams with them?

1 2 3
4 5 6
7 8 9

24) Do you think this project has made any difference to students in terms of the following:

a) Skills or knowledge?

a 1 2 3
4 5 6
7 8 9

b) Achievement?

b 1 2 3
4 5 6
7 8 9

c) Possible learning styles? Prompt - group learning, visual learning etc?

c 1 2 3
4 5 6
7 8 9

d) Motivation and attitude to their studies?

d 1 2 3
4 5 6
7 8 9

e) Classroom behaviour and interactions with other students?

e 1 2 3
4 5 6
7 8 9

f) Social development?

f 1 2 3
4 5 6
7 8 9

g) **Study habits?** Prompt - ability to do homework.

g 1 2 3
4 5 6
7 8 9

h) **Work on non-computer material?**

h 1 2 3
4 5 6
7 8 9

i) **Any other areas?**

i 1 2 3
4 5 6
7 8 9

25) **Now that you have been involved in the CAL project for a while what do you see as the major advantages (if any) of using computers in your classroom?**

1 2 3
4 5 6
7 8 9

26) **Now that you have been involved in the CAL project for a while what do you see as the major disadvantages (if any) of using computers in your classroom?**

1 2 3
4 5 6
7 8 9

27) Looking back over the year, and the experience that you now have, if this project were to be started at another school what advice would you give the teachers?

1 2 3

4 5 6

7 8 9

28) Are there any issues to do with computers or the CAL project that still need to be addressed? (Further software?)

1 2 3

4 5 6

7 8 9

29) With regard to the CAL project what are your plans for next year? Change around areas?

1 2 3

4 5 6

7 8 9

30) Are there any other comments you wish to make about the CAL project or the introduction of computers to your classroom?

1 2 3

4 5 6

7 8 9

Thank you for taking part in this interview. Are there any questions you would like to ask?

APPENDIX D : PNGHS October Diary

Record Sheet: Monday October 16 to Friday October 20

Please complete both sides of a record sheet as soon as possible after every lesson you take during the week of 16 - 20 October, for the subjects involved in the CAL project. For questions with multiple options please tick more than one if applicable.

Teacher code [ ]

1) Background information on lesson:

a) Lesson subject: Econ./Acc./Math. & Stat. **b) Level:** 6th/7th Form
c) Date of lesson: ...../...../..... **d) Lesson time:** ..... am/pm
e) Number of students in lesson: ..... **f) Number of student computers available** .....

2) How long did it take to plan this lesson? ..... minutes ..... hours

3) What specific objectives did you have for the lesson? Did any of these involve the use of the computers?

1 2 3
_____
4 5 6
_____
7 8 9
_____

4) What were the content areas to be covered during the lesson?

1 2 3
_____
4 5 6
_____
7 8 9
_____

5) How long did it actually take to cover the lesson you had planned? ..... minutes ..... hours

6) Please describe the fit between the lesson as planned and the actual lesson, including any computer work:

1 2 3
_____
4 5 6
_____
7 8 9
_____

7) Please indicate which types of classroom organisation were used for the lesson, and the approximate percentage of time (if any) spent in each type of organisation:

Organisation	**Approximate percentage of time spent**
☐ a) Students working in small groups **on** the computers	.....%
☐ b) Students working in small groups **off** the computers	.....%
☐ c) Students working independently **on** the computers	.....%
☐ d) Students working independently **off** the computers	.....%
☐ e) Teacher instruction of class	.....%
☐ f) Student instruction of class	.....%
☐ g) Solving software/hardware problems involving the whole class	.....%
☐ h) Other	.....%

8) If the students were working on the computer what were they doing?

☐ a) Computerised tutorials ☐ b) Note-taking
☐ c) Working on teacher-selected exercises ☐ d) Working on self-selected exercises
☐ e) Working on projects or assignments ☐ f) Other .....

9) Please rate the lesson in terms of the following:

a) During the lesson most students were:

Highly motivated	Moderately motivated	Neutral	Moderately unmotivated	Highly unmotivated
☐	☐	☐	☐	☐

b) The lesson was:

Totally teacher-centred	Mostly teacher-centred	Balanced teacher- and student-centred	Mostly student-centred	Totally student-centred
☐	☐	☐	☐	☐

10) What classroom management techniques did you use during the course of the lesson?

_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

11) Was any assistance required, by students, on:

☐ a) Any specific concepts in the lesson ☐ b) The broad lesson plan
☐ c) The software (computer packages) ☐ d) The hardware (machines)
☐ e) Other .....

12) Please describe any technical issues (if any) e.g., software, hardware or printing malfunctions, that occurred during the course of the lesson, and how these were solved:

_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

13) Are there any additional comments you wish to make on the lesson?

_____
_____
_____
_____ 1 2 3
_____ 4 5 6
_____ 7 8 9

Thank you for completing this record sheet.

APPENDIX E(a) ITS Assessment Part A

INFORMATION TECHNOLOGY SKILLS
SPREADSHEET
PART A

You have 20 minutes to complete this section of the test.

The following information shows the raw (actual) marks received for three tests by students of Greenville High.

Student	English	Science	History
Student 1	28	36	21
Student 2	42	50	42
Student 3	34	45	35
Student 4	23	36	26
Student 5	49	56	42
Student 6	25	34	37
Student 7	32	36	34
Student 8	16	24	21
Student 9	31	48	33
Student 10	44	57	43
Student 11	21	23	14
Student 12	46	51	35
Highest mark possible	**50**	**60**	**45**

COMPLETE THE QUESTIONS BELOW, FOLLOWING THE INSTRUCTIONS:

1) Using a computer prepare a **spreadsheet** showing the above information.

2) Give your spreadsheet a **title** and **headings**. Put all your titles and headings in **bold**.

3a) Calculate, **using a formula**, the average raw score for each subject. Show these results in a new row.

3b) **Format** the subject averages to 2 decimal places.

4a) Calculate, **using a formula**, the average for each subject as a **percentage.** Show these results in a new row.

4b) **Format** the subject percentages to 2 decimal places.

5) Place your **full name** on the **bottom left hand corner** of your spreadsheet.

6) **Print** your spreadsheet and **save** it, on the disk provided, called ***ittest.name.*** Use your **surname** as the **extension** (e.g. if your last name is Smith call your spreadsheet ***ittest.smith)***.

Note: Marks are allocated for the use of formulas and the formatting of column headings.

APPENDIX E(b) : ITS Assessment Part C

INFORMATION TECHNOLOGY SKILLS SELF EVALUATION PART C BEGINNING-OF-YEAR 1996

Your name: . . . .
(First) **(Last)**

Please place a tick in the box that corresponds to the skills you have:

I can:	**Yes**	**No**	**Not sure**
a) use a keyboard.	❑	❑	❑
b) use a mouse.	❑	❑	❑
c) use the help function on a computer.	❑	❑	❑
d) save information or files on a floppy disk.	❑	❑	❑
e) print files or documents.	❑	❑	❑
f) print multiple copies of a file or document.	❑	❑	❑
g) format a floppy disk.	❑	❑	❑
h) use a spell check to check documents.	❑	❑	❑
i) copy files from one disk to another.	❑	❑	❑
j) use cut and paste.	❑	❑	❑
k) enter data in a spreadsheet.	❑	❑	❑
l) edit data in a spreadsheet.	❑	❑	❑
m) format data in a spreadsheet (e.g., set to 2 decimal places or $).	❑	❑	❑
n) develop formulas in a spreadsheet (e.g., means or percentages).	❑	❑	❑
o) sort data in a spreadsheet.	❑	❑	❑
p) develop graphs from data in a spreadsheet.	❑	❑	❑
q) create documents using a wordprocessor.	❑	❑	❑
r) edit documents using a wordprocessor (e.g., ClarisWorks).	❑	❑	❑
s) format documents using a wordprocessor (e.g., changing fonts).	❑	❑	❑
t) import graphs or graphics into wordprocessed documents.	❑	❑	❑
u) use databases to find information (e.g., PCInfos, MacGlobe).	❑	❑	❑
v) access files stored in a central directory (e.g., shared file).	❑	❑	❑
w) use the internet/schools network/World Wide Web.	❑	❑	❑

APPENDIX F(a) : Student Tasks for Co-operative Exercises

Task 1

GROUP ASSESSMENT

TIME 30 Minutes

You have been supplied with an envelope which contains 21 individual accounts and their closing balances taken from the ledger of J. Small, a sole proprietor, on 30 June 1996.

However, you will discover that there are several duplicate accounts have been supplied to you.

YOU ARE REQUIRED TO:

1 Negotiate with the other three groups, by exchanging an account that you do not want for an account that you need.

2 Draw up a Trial Balance on 30 June 1996.

3 The Trial Balance must be completed manually and only one solution is required per group.

or

3 The Trial Balance must be completed on the computer and only one solution is required per group. Use the spreadsheet application and use the correct formulas where necessary.

CAPITAL	30,000
DRAWINGS	3,000
BUILDINGS	13,080
FURNITURE	2,220
STOCK	21,000
ABC BANK LTD INVESTMENT	1,368
RENT	2,016
PURCHASES	211,305
SALES	272,400
BAD DEBTS	405
ACCOUNTS RECEIVABLE	49,200
ACCOUNTS PAYABLE	34,263
INTEREST	300
RATES	600
SALARIES AND WAGES	31,761
TRAVELLING EXPENSES	429
DISCOUNT RECEIVED	411
DISCOUNT ALLOWED	147
GENERAL EXPENSES	6,075
PROVISION FOR DEPRECIATION: BUILDINGS	1,080
PROVISION FOR DEPRECIATION: FURNITURE	720

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Task 2

INSTRUCTIONS

You must make a note of the time at which your group commenced the task and the time that your group completed it.

Make a copy of the Trial Balance supplied on a spreadsheet or on your own paper.

Then

1 Construct suitable adjustment entries – **one** to illustrate each type below

- a Prepaid Expense
- b Accrued Expense
- c Revenue Received in Advance
- d Accrued Revenue
- e Depreciation of an Asset
- f One of your choice, excluding the types listed in 'a' to 'e' above.

A description of each adjustment entry must be handed in with the spreadsheet completed on either the computer or by hand according to the method you are using.

2 Enter the adjustment figures and complete the spreadsheet.

3 Calculate the **Proprietorship Ratio, the Working Capital Ratio and the Current Ratio for this business.** The formula, figures and answer must be completed on either the computer or by hand according to the method you are using.

4 Note the time that you finish the task.

1										
2	TRIAL BALANCE WORKSHEET AS AT 31 MARCH 1999									
3		TRIAL BALANCE			ADJUSTMENTS		ADJUSTED TRIAL BALANCE		INCOME STATEMENT	BALANCE SHEET
4		DR	CR		DR	CR	DR	CR	DR CR	
5	Accounts Payable			500						
6	Accounts Receivable	4500								
7	Advertising	3000								
8	Bank	12000								
9	Capital			34000						
10	Drawings	24000								
11	Equipment	40000								
12	Fees			84000						
13	Rent	5000								
14	Wages	30000								
15		118500		118500						

APPENDIX F(b) : Student Rating Schedules for Co-operative Exercises

STUDENT SELF-EVALUATION

Name: _____ **Group No.:** _____ **Date:** _____

a) ☐ **My group used a computer** ☐ **b) My group did not use a computer**

Please circle the number that corresponds to your opinion:

Problem-Solving and Planning Skills **During this task, I contributed to:**	Very Often	Often	Some-times	Seldom	Never
a) Identifying the problem or task to be done.	1	2	3	4	5
b) Planning an approach to solving the task.	1	2	3	4	5
c) Trying different approaches to solving the task.	1	2	3	4	5
d) Finding out facts, rules etc., which applied to the task.	1	2	3	4	5
e) Evaluating how the approach selected was working.	1	2	3	4	5
Social and Co-operative Skills **During this task, I:**					
f) Worked cooperatively with my group to accomplish the task.	1	2	3	4	5
g) Contributed to the activities of my group.	1	2	3	4	5
h) Decided actions and decisions with other group members.	1	2	3	4	5
i) Maintained my role(s) in the group for the duration of the task.	1	2	3	4	5
Communication Skills **During this task, I:**					
j) Listened to others' ideas in the group.	1	2	3	4	5
k) Shared my own ideas in the group.	1	2	3	4	5
Information Skills **During this task, I contributed to:**					
l) Organising and analysing the information available.	1	2	3	4	5
m) Using systematic methods for locating and fixing mistakes.	1	2	3	4	5
n) Presenting information in a clear and logical manner.	1	2	3	4	5
o) Using a computer/or written material to communicate ideas.	1	2	3	4	5
p) Completing the objectives set for the task.	1	2	3	4	5

Group Roles

During this task, I thought that:

		Very Often	Often	Some-times	Seldom	Never
q)	All group members had the opportunity to contribute.	1	2	3	4	5
r)	All group members shared in the more difficult as well as the easy aspects of the task.	1	2	3	4	5
s)	All group members were motivated and concentrated on the task.	1	2	3	4	5
t)	All group members accepted responsibility for their own suggestions and actions.	1	2	3	4	5

Student Roles

During this task, I took on the following roles:

	Some of the time	None of the time
1) **Thinker**	☐	☐
2) **Recorder/keyboard operator**	☐	☐
3) **Information organiser**	☐	☐
4) **Group leader/spokesperson**	☐	☐
5) **Negotiator**	☐	☐
6) **Encourager**	☐	☐
7) **Timekeeper**	☐	☐
8) **Other**	☐	☐

Use of Computers

If you used computers during this task:

9a) Do you think that using a computer helped you complete this task?

☐ a) Yes ☐ b) No

9b) If you answered "yes" to question 9a) how did using a computer help complete the task?

_____

_____ b 1 2 3

_____ 4 5 6

_____ 7 8 9

10a) Do you think that using a computer helped you work in a group?

☐ a) Yes ☐ b) No

10b) If you answered "yes" to question 10a) how did using a computer help you to work in a group?

_____

_____ b 1 2 3

_____ 4 5 6

_____ 7 8 9

APPENDIX F(c) : Observer Rating Schedules for Co-operative Exercises

CO-OPERATIVE AND GROUP BEHAVIOURS CHECKLIST

Observers name: _____ **Date:** _____

Group Number: _____ ☐ **a) Computer** ☐ **b) Non-computer**

Problem-Solving and Planning Skills

Students:	Very Often	Often	Some-times	Seldom	Never
a) **Identified the problem** or task to be done.	1	2	3	4	5
b) **Planned an approach** to solving the task.	1	2	3	4	5
c) Tried **different approaches** to solving the task.	1	2	3	4	5
d) Found out **facts, rules** etc., which applied to the task.	1	2	3	4	5
e) **Evaluated** how the approach selected was working.	1	2	3	4	5

Social and Co-operative Skills

f) Worked **co-operatively** within the group.	1	2	3	4	5
g) **Contributed** to group activities.	1	2	3	4	5
h) **Jointly** decided actions and decisions.	1	2	3	4	5
i) Maintained their **role(s)** in the group for the duration of the task.	1	2	3	4	5

Communication Skills

j) **Listened** to others' ideas.	1	2	3	4	5
k) **Shared** their ideas with the group.	1	2	3	4	5

Information Skills

Students:	Very Often	Often	Some-times	Seldom	Never
l) **Organised** and **analysed** the information available.	1	2	3	4	5
m) Used **systematic methods** for locating and fixing mistakes.	1	2	3	4	5
n) **Presented material** in a clear and logical manner.	1	2	3	4	5
o) Used computers/written material to **communicate ideas.**	1	2	3	4	5
p) **Completed** the **objectives** set for the task.	1	2	3	4	5

Student Roles

q) All had the **opportunity** to **contribute.**	1	2	3	4	5
r) All **shared** in the more difficult and easy **aspects** of the task.	1	2	3	4	5
s) All were **motivated** and concentrated on the task.	1	2	3	4	5
t) All **accepted responsibility** for their suggestions and actions.	1	2	3	4	5

Additional Comments

APPENDIX G : Tutorial and Lesson Evaluation Forms

EVALUATION OF A COMPUTER DEMONSTRATION OF CONFIDENCE INTERVALS

Name: . . . . . **Class teacher:** . . . . . **Date:** . . . / . . . / 1996

1) Please circle the number that corresponds to how you feel about the computer demonstration of confidence intervals:

a)	Simple to understand	1	2	3	4	5 . . : .	Complicated to understand
b)	Confuses understanding of concepts	1	2	3	4	5	Aids understanding of concepts
c)	Unclear	1	2	3	4	5	Clear
d)	More interesting than other teaching methods . . .	1	2	3	4	5	Less interesting than other teaching methods
e)	Wastes time	1	2	3	4	5	Saves time
f)	Focused on theory	1	2	3	4	5	Focused on calculating problems
g)	Increased my personal interest in topic	1	2	3	4	5	Decreased my personal interest in topic
h)	Focused on mathematics with statistics content	1	2	3	4	5. . . .	Focused on computers

2) How clear do you think your understanding of confidence intervals is now?

☐ a) Very clear ☐ b) Clear ☐ c) Neither clear nor unclear ☐ d) Unclear ☐ e) Very unclear

3) What do you understand a 95% confidence interval to be?

0 1
2 3

4) Please describe a practical example of a confidence interval:

0 1
2 3

5) Is there any form of additional instruction that could help increase your understanding of confidence intervals (please describe)?

1 2 3
4 5 6
7 8 9

EVALUATION OF LESSONS ON CONFIDENCE INTERVALS

Name: . . . . . **Class teacher:** . . . . . **Date:** . . . / . . . / 1996

1) Please circle the number that corresponds to how you feel about the explanation of confidence intervals:

a)	Simple to understand	1	2	3	4	5	Complicated to understand
b)	Confuses understanding of concepts	1	2	3	4	5	Aids understanding of concepts
c)	Unclear	1	2	3	4	5	Clear
d)	More interesting than other teaching methods . . .	1	2	3	4	5	Less interesting than other teaching methods
e)	Wastes time	1	2	3	4	5	Saves time
f)	Focused on theory	1	2	3	4	5	Focused on calculating problems
g)	Increased my personal interest in topic	1	2	3	4	5	Decreased my personal interest in topic

2) How clear do you think your understanding of confidence intervals is now?

☐ a) Very clear ☐ b) Clear ☐ c) Neither clear nor unclear ☐ d) Unclear ☐ e) Very unclear

3) What do you understand a 95% confidence interval to be?

0 1

2 3

4) Please describe a practical example of a confidence interval:

0 1

2 3

5) Is there any form of additional instruction that could help increase your understanding of confidence intervals (please describe)?

1 2 3

4 5 6

7 8 9

APPENDIX H(a) : Economics Assignment

TOPIC: **MARKET STRUCTURES IN NEW ZEALAND**

AIM: To investigate the theory of market structures and relate the theory to **ONE** New Zealand example.

METHOD: Identify the types of market structures in New Zealand and outline their characteristics. Select an example of **ONE** market type and complete an indepth investigation to ascertain how well your example conforms to the theory.

Your research framework should include:-

- Criteria used for classification.
- Comparison of strategic behaviour, profitability, efficiency, and progressiveness across markets (e.g., once a perfect competitor always a perfect competitor?)
- Using an example, apply your knowledge of economic theory of the firm to your chosen example, i.e.,
  - Investigate the special features which determine its market type.
  - Does it comply in all respects to the model?
  - What is the future of your firm?

The report should not exceed **2500 words**.

APPENDIX H(b) : Economics Rating Scales

A) What is the quality of economic analysis and interpretation of findings?

1 = **Very low quality**
   a) Theory or case study absent or assignment requirements totally misunderstood.
   b) Conclusions/interpretations absent, totally unsupported or invalid.

2 = **Low quality**
   a) Significant aspects of assignment requirements misunderstood. Outlines aspects of relevant theory but at least one key error or omission (eg. omits consideration of a market type, firm's behaviour, profitability, or efficiency).
   b) Conclusions mostly invalid or unsupported.

3 = **Average quality**
   a) Describes relevant theory (some minor errors/omissions) correctly but no integration of theory and case study (i.e. market structures and case study unrelated).
   b) Conclusions reached that are mostly valid and supported.

4 = **High quality**
   a) Relevant theory described in full. Partially integrates theory and findings (e.g. makes general references to theory and practical behaviour of firm in case study).
   b) Valid conclusions reached that are fully supported.

5 = **Very high quality**
   a) Covers relevant theory in full. Fully integrates theory and findings.
   b) Valid conclusions/interpretations reached that are fully supported and show economic insight.

B) Is an appropriate range of economic language used?

1 = **Very inappropriate range**
   a) No economic terms used.

2 = **Inappropriate range**
   a) 1-4 relevant terms defined accurately.

3 = **Average range**
   a) 5-8 relevant terms defined accurately.

4 = **Appropriate range**
   a) 9-12 relevant terms defined accurately.

5 = **Very appropriate range**
   a) 13 or more relevant terms defined accurately.

C) Were appropriate graphs or tables used?

1 = **Absent**
   a) No graphs/tables present.

2 = **Below average**
   a) Graphs/tables contain major errors (e.g., labelling axes, curves not labelled, incorrect drawing of AC curve, MC does not equal minimum AC).
   b) A key graph (e.g., monopoly equilibrium) missing or graphs may be irrelevant.

3 = **Average**
   a) All key graphs etc presented (i.e., equilibrium diagrams for each market structure).
   b) A few (<3) minor errors or omissions evident in graphs/tables.

4 = **Above average**
   a) Key relevant graphs etc presented accurately.
   b) No basic errors but some complex errors (e.g., oligopoly diagram lacks 2 MR curves).

5 = **Superior**
   a) All relevant graphs/tables presented accurately (ie., no errors and no irrelevancies).
   b) All defined as equilibrium diagrams for perfect competition (e.g., both industry and firm), monopoly, monopolistic competition, and oligopoly, PC diagram showing shut-down.

D) What is the quality of the editing and the writing?

1 = **Very poor quality**
   a) Lacks basic editing, repetition of points, text disjointed and very difficult to read.
   b) Many incorrect sentence and word structures.
   c) Little evidence of accurate paragraphing. Illogical paragraph order.

2 = **Poor quality**
   a) Little basic editing evident, some repetition of points. Difficult to read.
   b) Some incorrect sentence structures.
   c) Paragraphing evident but not consistent. Order not always logical.

3 = **Average quality**
   a) Some evidence of editing obvious. Reasonably easy to read.
   b) Simple and accurate sentence structuring.
   c) Paragraphing evident. Mostly in logical order.

4 = **High quality**
   a) Evidence of editing obvious. Little repetition of points. Easy to read.
   b) Clear and accurate pattern or range of sentence structures.
   c) Paragraphing clear and in logical order.

5 = **Very high quality**
   a) Well edited, no repetition of points, text flows smoothly and very easy to read.
   b) Clear and accurate use of a wide range of sentence structures and lengths.
   c) Consistent and clear paragraphing. Very logical paragraph order.

E) How well is the report presented?

1 = **Very poor presentation**
   a) Layout incoherent - no heading or sections.
   b) Graphs/tables poorly presented and difficult to follow.
   c) Many (16 or more) basic spelling and grammar errors.

2 = **Poor presentation**
   a) Inconsistent headings and divisions between sections of task unclear.
   b) Graphs/tables contain basic presentation errors (i.e., lack title, size, messy, lack key, etc).
   c) Many (11-15) basic spelling and grammar errors.

3 = **Average presentation**
   a) Clear layout, consistent headings and divisions between sections.
   b) Graphs/tables well set out.
   c) Minor (6-10) errors of spelling and grammar.

4 = **Above average presentation**
   a) Clear layout.
   b) Graphs/tables well presented (e.g., use of shading/colour, size, clear key, etc).
   c) A few (1-5) errors of spelling and grammar.

5 = **Superior presentation**
   a) Layout clear.
   b) Well presented graphs/tables.
   c) No spelling or grammatical errors.

APPENDIX I : Additional Tables

Table I-1

PNGHS: Parents' Socio-Economic Status

	Start 1995		Start 1996	
	Mother N = 146 %	Father N = 143 %	Mother N = 90 %	Father N = 92 %
1 - Higher professional and administration	14	27	17	23
2 - Lower professional, technical, and executive	13	17	12	18
3 - Clerical and highly skilled	26	17	34	27
4 - Skilled work	25	28	20	21
5 - Semi-skilled	7	7	3	10
6 - Unskilled	2	1	1	1
7 - Unpaid	14	3	12	-

Table I-2

School X: Parents' Socio-Economic Status

	Start 1995		Start 1996	
	Mother N = 115 %	Father N = 116 %	Mother N = 115 %	Father N = 119 %
1 - Higher professional and administration	22	24	20	31
2 - Lower professional, technical, and executive	24	42	19	32
3 - Clerical and highly skilled	30	19	31	17
4 - Skilled work	9	14	16	13
5 - Semi-skilled	6	1	-	4
6 - Unskilled	-	-	-	1
7 - Unpaid	10	-	14	2

In 1995, both the mothers and fathers, and in 1996, the fathers of School X students were more likely to be located at the upper end of the scale, i.e. of higher economic status. The mothers of students at both schools were more likely to be located at the lower end of the scale compared to the fathers.

REFERENCES

Anderson, B. (1995). IT use in education: Whose agenda, whose decisions? *Computers in New Zealand Schools, 7*(2), pp. 25–28.

Asp, G., Dowsey, J., and Stacey, K. (1993). Teaching mathematics with technology: Computer spreadsheets and graphing applications. In J. Mousley & M. Rice (Eds.), *Mathematics of primary importance*. Victoria: The Mathematical Association of Victoria.

Atmore, D. (1995). *Schools network evaluation*. Wellington: New Zealand Council for Educational Research.

Chamberlain, M., & Kennedy, S. (1991). *A case of "Growing Like Topsy": A study of the use of computers for teaching and learning in two New Zealand schools*. Wellington: Ministry of Education.

Consultative Committee on Information Technology in the School Curriculum. (1990). *Report of the consultative committee on information technology in the school curriculum*. Wellington: The Committee (available from the Ministry of Education).

Elley, W., & Irving, J. (1985). The Elley-Irving socio-economic index 1981 census revision. *New Zealand Journal of Educational Studies, 20*(2), pp. 115–128.

Gardner, J., Morrison, H., Jarman, R., Reilly, C., & McNally, H. (1992). *Pupils' learning and access to information technology*. Belfast: The Queen's University of Belfast, School of Education.

Gilmore, A. (1993). I've had the training: What now? *Computers in New Zealand Schools, 5*(1), pp. 16–23.

Hartley, J. (1993). Writing, thinking and computers. *British Journal of Educational Technology, 24*(1), pp. 22–31.

Hawk, K. (1996, June 5). Ten technology lessons for other schools. *New Zealand Education Review*, p. 11.

Lai, K-W. (1992). Computers in education: A learner-centred approach. In K-W. Lai & B. McMillan (Eds.), *Learning with computers: Issues and applications in New Zealand*. Palmerston North: Dunmore Press.

Lai, K-W. (Ed.). (1996). *Words have wings: Teaching and learning with computers networks*. Dunedin: University of Otago Press.

Lai, K-W., & McMillan, B. (Eds.). (1992). *Learning with computers: Issues and applications in New Zealand*. Palmerston North: Dunmore Press.

McKinnon, D. (1995). *Computers, experiential learning and subject integration in the secondary school: A longtitudinal case study of students' attitude, motivation and performance. Volume I and II*. PhD thesis. Sydney: University of Sydney.

Maurer, M., & Simonson, M. (1984). *Computer anxiety index (version AZ)*. Iowa: Iowa State University Research Foundation Inc.

Miller, F., & Varma, N. (1994). The effects of psychosocial factors on Indian children's attitudes towards computers. *Journal of Educational Computing Research, 10*(3), pp. 223–238.

Ministry of Education. (1993). *The New Zealand curriculum framework*. Wellington: Learning Media Limited.

Ministry of Education. (1994). *Education for the 21st century*. Wellington: Learning Media Limited.

Ministry of Education. (1996). *New Zealand schools: Statistical annex*. Wellington: Learning Media Limited.

Mitchell, J., & Loader, D. (1993). *Learning in a learning community: Methodist Ladies' College case study. No. 2*. Melbourne: Incorporated Association of Registered Teachers of Victoria.

Naidu, R. (1994). *Do computer simulations make teaching and learning the law of long run probability and the central limit theorem more successful?* Unpublished MA thesis. Hamilton: University of Waikato.

Nightingale, D., & Chamberlain, M. (1991). *A study of computers in New Zealand schools*. Wellington: Ministry of Education.

Owens, J. (1996). A survey of computer use in New Zealand schools. *The Research Bulletin*, No.7, November. Wellington: Ministry of Education, Research Section.

Pelgrum, W., & Plomp, T. (1996). Information technology and children from a global perspective. In B. Collis, G. Knezek, K-W. Lai, K. Miyashita, W. Pelgrum, T. Plomp, & T. Sakamoto, *Children and computers in school*. New Jersey: Lawrence Erlbaum Associates.

Pelgrum, W., Janssen Reinen, I., & Plomp, T. (Eds.). (1993). *Schools, teachers, students and computers: A cross-national perspective. IEA-Comped study stage 2*. The Hague: International Association for the Evaluation of Educational Achievement.

Philips, D. (1995). *Evaluation of exploratory studies in educational computing. Using the word processor to develop skills of written expression*. Wellington: New Zealand Council for Educational Research.

Podmore, V., & Craig, B. (1989). *Evaluation of exploratory studies in educational computing. Study 9: The impact of microcomputers on teachers and in the observable behaviours of children aged four to seven years*. Wellington: New Zealand Council for Educational Research.

The Privacy Act. (1993). Wellington: The New Zealand Government.

Ronen, M. (1995). A 3-D motion tracing system in high school physics teaching. *Journal of Computer Assisted Learning, 11*(3), pp. 141–158.

Rowe, H. (1993). *Learning with personal computers*. Melbourne: Australian Council for Educational Research.

Ryba, K., & Anderson, B. (1990). *Learning with computers: Effective teaching strategies*. Oregon: International Society for Technology in Education.

Shears, L. (Ed.). (1995). *Computers and schools*. Melbourne: Australian Council for Educational Research.

Simonson, M., Montag, M., Maurer, M., Oviatt, L., & Whitaker, M. (1992). *Test adminstrators manual for the standardized test of computer literacy and computer anxiety index*. Iowa: Iowa State University Research Foundation, Inc.

Stanford University School of Education. (1986). *Computers and education: Which role for international research?* A report on the Stanford/UNESCO symposium, 10–14 March 1986. Paris: UNESCO.

Stead, R. (1990). Problems with learning from computer-based simulation: A case study in economics. *British Journal of Educational Technology, 21*(2), pp. 106–117.

Stirling, W. (1992). Teaching elementary inference with computer-based simulations. In D. Vere-Jones (Ed.), *Proceedings of the Third International Conference on Teaching Statistics (ICOTS 3)*. Dunedin: International Statistical Institute.

Thomas, M. (1995). *Computers in the New Zealand mathematics classroom: Where are we and where are we going?* Paper presented at the 17th Annual New Zealand Association for Research in Education conference, Massey University, Palmerston North.

Van der Klay, M. (1992). Writing using a wordprocessor. In K-W. Lai & B. McMillan (Eds.), *Learning with computers: Issues and applications in New Zealand.* Palmerston North: Dunmore Press.

Watson, D. (Ed.). (1993). *The ImpacT Report: An evaluation of the impact of information technology on children's achievements in primary and secondary schools.* London: King's College (for the Department for Education).

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